ANNUAL ROAD ISSUE

January 6, 1927

Engineering News-Record

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Editor

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Engineering News-Record is a consolidation of *Engineering News* and *Engineering Record*, effected in 1917.

Engineering News was founded in 1874 by George H. Frost, as the *Engineer and Surveyor*, which title subsequently became the *Engineer, Architect and Surveyor*, then *Engineering News and American Railway Journal* and finally *Engineering News*, under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as the *Plumber and Sanitary Engineer*. The name was subsequently changed to the *Sanitary Engineer, Engineering and Building Record* and, finally to *Engineering Record*. During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The Contractor was consolidated with *Engineering News-Record* in 1918.

E. J. Mehren became editor of *Engineering News-Record* at the time of the consolidation in 1917, and was succeeded by Frank C. Wight, Jan. 1, 1924.

The staff of *Engineering News-Record* consists of

New York: Frank C. Wight, *Editor;* M. N. Baker, F. E. Schmitt, C. S. Hill, J. W. Shaver, V. T. Boughton and W. G. Bowman.

Chicago: E. E. R. Tratman, W. W. DeBerard *(on leave of absence)*.

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A Continuing Industry

ROADBUILDING is the most promising of the construction industries. It shows no sign of diminution, nor short of a national calamity does it promise any diminution for years to come. The demand for more and better roads is insistent and the saturation point in this demand is yet a long way off. The only limit to the new road mileage is the financial capacity of the community. It is a fact that in places this limit is in sight, but taking the country as a whole there is money enough for as much new and improved mileage as it is possible economically to build. The difficulty lies in finding how best to levy and to distribute the burden of the tax. Gradually, however, this problem is being solved and its difficulty of complete solution does not keep the building of highways from being one of the most important of the tasks before the engineer. For that reason no apology is needed, or offered, for the devotion of a large part of one issue of a journal for engineers and constructors to the subject of highways. The occasion is the annual gathering of the roadbuilding clans at Chicago. But the appeal of the subject is wider, wide enough to include all those interested in what the engineer thinks and does, regardless of whether for the moment their minds and hands are set to this particular specialty.

A 1927 Reform

ROAD safety has become a major issue during the past year. Engineers and highway men of all types are studying it intensively and are planning large expenditures in construction to eliminate traffic dangers. But without expenditure of a single dollar a greater improvement in safety can be brought about than by millions of road expenditure. This is through the simple enforcement of existing headlight laws. There is extensive and glaring abuse of headlights, and it creates the greatest single danger of the road today. Blinding headlights seem to characterize make of car rather than owner and operator, and for that reason should be more quickly and effectively dealt with. So long as there is a large number of blinding headlights on the road, efforts toward greater traffic safety are handicapped. It is conceded that the headlight art is still imperfect; but the best practice is so excellent, and the worst so execrable, that there can be no ground for failing to eliminate blinding lights. Laws already on the statute books in most of our states are adequate to condemn and punish the evil. It only needs a genuine effort on the part of state officials to enforce them. Abolition of blinding headlights is a good new year's wish for the road user. If traffic officials would make a corresponding resolution, and carry it out with better consistency than tradition attaches to new year's resolutions, a real improvement would be accomplished.

Light On Los Angeles Flood Protection

BY THE appointment of Messrs. Marx, Fowler and Paul to make a complete new survey of the flood protection plans of the Los Angeles County Flood Control District the Board of Supervisors of that county has done everything that a reasonable critic of those plans could ask. There is much politics being played in Los Angeles today, there are all kinds of reasons why people are for or against the flood protection scheme developed by J. W. Reagan, as chief engineer of the district, and backed by the county authorities, and only a few of them hinge on engineering matters. But it has been evident from the beginning that the county's flood control plan was an individualistic piece of engineering, that such consulting engineers as had been brought in had reported only on specific details however much their names had been used subsequently to justify the plan as a whole, and that until a thorough unprejudiced outside engineering examination of the hydraulic, structural and economic needs of the situation

had been made great doubt could well be cast on the whole expenditure that Los Angeles was committing itself to. The new consulting engineers supply just this need and when their report is made available Los Angeles and its neighbor communities will be able to know, what to date they have not known, whether the proposed flood protection scheme with its ultimate cost of a hundred or more million dollars has the approval of considered engineering opinion or whether it is the unsupported notion of one engineer.

Rational Snow Removal Demanded

NO APPRAISAL of highway maintenance development may properly ignore the large activity that snow removal has become. This winter 93,000 miles of trunk road are being cleared of snow. To do this 3,500 snow plows and 5,500 tractors and trucks are being employed. Approximately 1,500 miles of snow fence will be set up. These figures are extended from the counts of the Bureau of Public Roads for last winter and it is believed they are smaller than will actually be recorded. Last winter too, for about the same mileage kept open, the cost was $3,750,000. It should not be any less this winter. With this investment and expenditure where have we arrived in snow removal practice? There are questions of snowfall conditions—of distribution, volume, frequency and depth of fall; of frost, thawing and wind action. There is the supreme question of determination between drift prevention and snow removal proper. There is the question of removal procedure—continuous clearing as the snow falls or clearing by one operation as the storm ends. There are questions of equipment selection and questions of path widths and of snow disposal as affecting drainage and spring breakup. There are the vital questions of fitting the service to the traffic and of the justifiable cost of service. Where are the answers? A survey of current practice swamps us with many answers. From a census of opinion only a confusion of councils is had. There is only one study of snowfall as it affects highways to which the maintenance engineer can go for fundamental information: the Michigan highway department survey by V. R. Burton. The conclusions determined apply specifically to one state but many of them have general application. With corresponding determinations for a dozen states there would be fundamental data for a rational practice of snow removal. Now we have only a process of trial and discard.

Less Haste, More Speed

THE demand for speed and the incentive to setting up new records will always be present in the construction industry. Time is money and time economies are rated on a parity with economies in cost. This is a healthy condition up to a certain point, then comes the danger of overdoing it. In the face of the ever-increasing urge for speed it is well for engineers occasionally to pause and consider the dangers and disadvantages that may result from an over-emphasis of speed. In addition to the added risk to life and limb, under the urge of speed workmen tend to develop habits of carelessness and inefficiency in matters not directly affecting the speed to which they give a paramount place. With an eye to saving time they are a little less careful and a little less considerate of the refinements of the work in hand. On many jobs rush construction is unavoidable but there are many more where a little foresight on the part of owner or banker would make rush methods unnecessary. The engineer can help to improve this situation by stressing the higher cost of rush jobs. The Industrial Accident Commissions of the various states could—and doubtless, to some extent, do—campaign against rush construction. Warnings of this sort might well suggest that where rush construction is unavoidable additional appropriations should be made for the special attention that safety features should receive on rush work. This still leaves unremedied the slighting of the refinements in efficiency and care that inevitably result when speed is made paramount; these losses are among the penalties that must be paid for over-zealous attempts to speed up.

Road System-Location

THEORIES of highway system-location do not occupy a forward place in the daily practice of the practical road builder. For the most part there is no occasion for them. Legislative fiat has laid down our road systems and liberty of engineering selection seldom goes further than individual route realignment. Therefore the fundamentals of system-location as set forth in this issue by W. G. Sloan, state highway engineer of New Jersey have the stimulating fillip almost of strange doctrines. Briefly the theory rests upon a determination of traffic flow, a definition of traffic districts and a hypothesis that traffic flow between districts may not rightly intermingle or intersect. The argument need not be developed here. It is more important to direct notice to the fact that in the New Jersey system-location we have an example of engineering procedure as distinguished from political log-rolling and legislative pronouncement. New Jersey has full knowledge of the latter methods. It may now see an example of the former. And other states can wisely assimilate the lesson. Whether the New Jersey state road engineer's theory is or is not criticism proof, it puts highway system-location on a rational basis and this has been a rare occurrence in our highway history. Road officials will find interest in the traffic-flow, system-location map of New Jersey's proposed comprehensive highway system.

For a St. Lawrence Waterway

SPEECHES by Secretary Hoover and the report of the engineering commission a few weeks ago have discounted the news value of the report of the United States St. Lawrence Commission favoring a Lakes-to-Ocean deep waterway via that international stream. The commission has been studying the problem for nearly three years. That study has comprised not only a thorough investigation of the economic considerations but a fairly expensive engineering examination, to say nothing of diplomatic exchanges with the other party to the proposal, the Dominion of Canada. The result is an unequivocal indorsement of the St. Lawrence seaway, not only in itself but in preference to the alternative plans for canals connecting the Hudson with both the lower and the upper Great Lakes. As to the preferential recommendation there can be no question. A ship canal through New York State would be an unwarranted expenditure at any time in the predictable future. The

need for such a waterway is doubtful, its cost is prohibitive and its probable use by large vessels entirely problematical. Proposals for it bear every mark of obstruction or unwarranted selfish interest. The St. Lawrence canal, on the other hand, purely as an economic development is desirable on all three of the counts which make the other canal undesirable. Further than that Secretary Hoover's report is correct when it says that the power development on the St. Lawrence "will eventually create a shipway on this route even if other routes were undertaken." We have undoubtedly come to the time in our national growth when we should open the Great Lakes to the sea, and no other proposal has the physical and economic attractiveness of the St. Lawrence route. That being accepted, this country can then proceed to the negotiations with our neighbor on the north which will lead to a mutually beneficial and mutually acceptable plan of action. Just what that plan should be need not be discussed now. The thing for the United States to do is to announce, by congressional action if need be, that we are prepared to go ahead with the scheme if Canada will agree, and then leave to the two executives the working out of plan which can be adopted by both countries.

Frontage as a Basis for Assessments

ALTHOUGH containing little that is new in principle and not having the finality of a decision of the United States Supreme Court the ruling on repaving assessments in the District of Columbia abstracted elsewhere in this issue is significant and of wide general interest. Much of the opinion rests on decisions of our highest courts, state and federal, and therefore it unlikely to be upset. All of it is based on common sense.

It was pointed out in these columns some weeks ago that the heavy growth of motor vehicle travel and traffic makes it absurd now, however it may have been before, to burden adjoining property with the entire cost of the kind of pavement demanded for motor-propelled vehicles. In the Washington case just decided the entire cost of repaving one of the main diagonal avenues of Washington, forming a part of a through route to Baltimore, was assessed against abutting property on a block-by-block front-foot plan. The injustice of such an assessment seems too apparent to require supporting argument, yet the plan had the warrant of a Congressional Act, applicable to all of Washington, while under a supplementary act property owners had no right to a hearing before the work was ordered. The decision will contribute materially to the relief of abutting property owners throughout the country. In other words, we may expect to see more and more of the cost of street pavements go into the general tax levy.

Where assessments for benefits are permissible, the current decision in its limitations to prevent discrimination and even confiscation, does not leave much scope for the front-foot plan. That is, it goes so far in suggesting uniform lot depths and other conditions that either the front-foot plan would be ruled out or else it would be reduced to very much the same pro rata basis as was prescribed by the Congressional Act that the court holds invalid. After all, that is what the out-and-out front-foot plan amounts to. It measures total benefit by total cost, assumes that all the benefit is local to the frontage of the improvement and then prorates it according to ownership.

It is not the function of a court to go beyond the immediate questions at issue so the court in the present instance very properly stopped short with the limitations on the front-foot plan. This does not prevent others from going further: To what extent is frontage an adequate measure of the benefit conferred on a property owner by paving, repaving or any of the other classes of public improvements for which benefit assessments are sometimes levied?

Cross Joints in Concrete Roads

A STUDIOUS argument is given in this issue in favor of regular cross joints in concrete road slabs. Virtually a theory of transverse joint spacing is developed. Without querying either argument or theory, it is interesting to consider in their light tendencies in transverse joint practice as developed in recent engineering discussion.

Two months ago at the meeting of the Association of State Highway Officials a count was presented which showed that 30 states use regularly-spaced cross joints. Their spacing practice varies and joint widths and joint structures have little uniformity. Against this numerical preponderance was set the experience of the few states which employ no transverse joints but among them being the oldest users or the largest users of concrete roads in the country. An outstanding example is Illinois with 5,000 miles of concrete roads built in seven years without transverse joints except at bridges. Contraction cracking has occurred but expansion blowups have not averaged one in five miles of road and the contraction cracks are no more numerous than would cross joints, as ordinarily spaced, have been. The conclusion was argued from this record that cross-cracks are no more objectionable as breaks in the slab continuity than joints would have been and the considerable cost of joint construction has been saved. Reviewing "all the available research data" as well as the construction experience of five years an engineer of the Bureau of Public Roads concluded that "Transverse expansion joints should only be provided where previous experience has shown that numerous and costly blowups will occur where no provision is made for expansion."

At the international road congress in September the eminently safe conclusion was arrived at that "Opinion is divided upon the advisability of transverse joints" and therefore "research should be continued." Incidentally European engineers use transverse joints generally; indeed from the American standpoint they go to excessive lengths to meet expansion and contraction by joint construction.

So we have the cross-joint situation; Theory based on knowledge of thermal and moisture expansion which proves the necessity of cross joints; practice which employs them generally but is not in agreement regarding spacing, width and structure; experience which indicates that they are commonly not essential; and opinion which agrees with practice and is backed with as little assurance. Certainly the situation asks for simplification; it is perhaps again time to renew the discussion of rational joint-design practice. The article in this issue is a lucid beginning.

An Examination of Highway Problems and Practice

Road Building Continues at High Peak—Is It Falling into a Routine Which Indicates Stability but Which Holds Danger to Progress?

—AN EDITORIAL REVIEW—

HIGHWAY construction and maintenance activities show no diminution. The statistics for 1926 are not yet available, but estimates by the Bureau of Public Roads indicate that the figures of 1925 will be equaled. This means a total expenditure in road improvement of $1,300,000,000, about half of which will have been spent on state systems. The mileage constructed, including about 5,000 miles graded and drained only, will be about 23,000. This includes some 10,000 miles of federal aid roads. In 1927 we may expect, from all indications, closely corresponding figures. Highway construction and maintenance is a continuing business, a little larger each year but not greatly different in character, and so it is a continuing market for equipment and materials, engineers and contractors. The record of 1926 runs true to form.

Engineering Design—Practice in 1926 recognized increased liberty in road relocation. This extended beyond line rectification and curve easement. New locations were built upon for considerable mileages and the old roads abandoned or relegated to local service. The practice increased of bypassing cities in main route relocation. With relocation and line rectification have come a lowering of grades and an easement of curves, but the permissible maxima have not been reduced. Widening and superelevating of curves have been more generally accepted practice. More generally, also, the 10-ft. traffic lane has been accepted as right, and 20 ft. is being adopted as the standard two-way pavement width. There is wide division of opinion on the three-lane road, but in a measure its position has improved as meeting economically the condition where peak traffic is one direction in the morning and the other direction at night as on some city-to-suburbs roads.

The design of concrete roads has undergone no change since the thickened-edge, center-joint, doweled-joint design was developed, but there has been an extension of the use of the new design. A recent count shows that 39 states have now adopted it. Present cross-sections are based on 8,000-lb. wheel loads. It is not evident that reinforcing is gaining advocacy but where it is used the tendency is toward heavier steel. Also, there is no evidence that practice and opinion in respect to transverse joints have materially altered; if there is any change, it is a drift toward more general use. In a general way, too, the assertion seems warranted that pavement cracking and means of localizing cracking are arousing wider concern; experimentation with planes of weakness is an evidence of this concern.

Bituminous and brick roads have both made a break toward new practices, although actual construction of the new designs is more a promise of the future than a record of the year just passed. Besides a swing toward stiffer mixes of sheet asphalt, there developed a strong urge toward a thickened-edge design for penetration macadam and asphaltic concrete roads. In brick road practice the large advance has been the development of a thin-brick creed based on the elaborate tests of the Bureau of Public Roads disclosing the ample load-carrying and wear-resisting capacity of 2½-in. brick on a rigid base.

Road concrete mixtures have been held at their high standards of proportions, consistencies and materials. There has been some experimenting with water-cement ratio proportioning, with sand inundation, with proportioning by weighing and with accelerating admixtures, but specification requirements and limitations stand in general as they have stood for several years. Nor have specification requirements altered generally for brick paving or asphalt. Incidentally, the old road types, concrete, bitumen, brick, gravel and sand-clay, continue in about the old order of popularity. Special quick-setting cement (high alumina cement) concretes are being felt out for patching and for paving underpasses or other places where quick admission of traffic is desired. Some uncertainty of their action but more their high cost keep them from wider use. There has been similar trial of high early strength concretes made from the regular portland cements, by the use of more careful methods of mixing and placing. Altogether, the year showed increased consideration and scrutiny of materials and means designed to hasten the speed with which concrete pavements and pavement bases can be thrown open to traffic.

Design of subgrade structure has not progressed. It remains the neglected item of road engineering. Markedly greater recognition is, however, being evidenced of the presence of subgrade design problems. Activity exists mostly in survey and research—soil studies, earth slide surveys, and earth road surveys—and not in improved structure of subgrade.

Larger Planning Problems—The will to secure wider right-of-way has continued. Generally, highway officials have espoused the doctrine that a good width between fence lines is an essential of a good road, and they have striven for this width very generally. In a measure, their minds have been pointed toward this need by the increasing demand for widening old roads. In most states having paved roads ten years old, widening has in the last two years reached the stature of a major road improvement operation. A notable technique has been developed where it is most practiced.

The year, however, has not shown any considerable extension of the movement toward four-lane and wider arterial roads. There has been talk and the projects of 1925 have been continued, but new undertakings or even fundamental study of such traffic routes have not developed. Also, there has been talk of specific toll road undertakings and general talk of toll road possibilities but this has come from outside the highway de-

partments and has had no open recognition in official road circles. The toll road apparently occupies no place in official thinking.

Grade Crossing Elimination—Continued pressure has been exerted toward grade crossing elimination. So far, however, its effects are manifested by more amiable relations between railways and state road departments rather than by extraordinary construction activity. In the year, New York, with its three hundred millions in bonds voted in 1925, has formulated plans and is prepared to go ahead with actual construction. Generally throughout the states, accomplishment in grade-crossing removal is due (1) to individual grade-separation contracts negotiated one at a time with the railways, and (2) road relocation which removes the crossing and to which the railway does not usually contribute. Blanket agreements with the railways on a systematic crossing elimination program are promising features.

Construction Practice—Construction by contract gained increased favor in 1926. The inclination toward force account construction has weakened. In the technique of construction there has been improvement in "form" or finesse. More operations are performed by machines and machines are more skillfully operated. The paved road of 1926 has been a better turned out product than any previous year's roads. There is yet a long way to go to secure the construction efficiency that is possible; between the well-directed and the average operation there is too wide a separation in cost, speed and smooth operation. In the broad problem of road construction-engineering efficiency, the year being considered emphasized the fundamental weakness of road builders in combatting delays, rainy weather and seasonal operation. As the result of their complete subjection to the rain, contractors in a score of large road building states last fall left thousands of miles of road lying incompleted through the winter. A rainy month or six weeks virtually stopped dead a vast construction business.

Maintenance Methods—As every successive year is doing, last year demonstrated how maintenance is creeping up on construction as the major road improvement operation of the nation. Like design and construction, road upkeep in 1926 showed an extension of good practices rather than any development of new practices. Indication was given as the year went by that closer compliance with the requirement for federal-aid road maintenance was being demanded. Also, there appeared an increasing sentiment for eliminating county participation and direction in state road maintenance. Confined a few years ago to a few states and to a few main routes, snow removal has become general practice and many states are keeping their entire state road mileage open to traffic all winter. As a result, a technique of snow control, combining drift prevention and snow removal, and an equipment practice, are being rapidly developed. With snow removal there is now year-round employment for maintenance organizations and plant. Maintenance is putting road improvement securely on the basis of a continuing business—a permanent consumer of labor and equipment.

Administration and Financing—The swing toward centralization in road administration advanced. Independence of the county, in state road management, and assumption by the county of township road management, both recorded progress in 1926. This has not been an unobstructed movement; local rights sentiment is a strong force and is not without reason. Yet it is fact that opinion is growing that primary road administration is the state's task exclusively, and that secondary roads should comprehend all but the state roads and should be the county's task to administrate.

In financing roads, 1926 records no innovations. More states enacted gasoline tax laws or amended existing laws to increase gasoline tax rates. Four states, New York, New Jersey, Massachusetts and Illinois, continue to be the only ones in which no gasoline tax is levied. No states voted bonds for road improvement. There were, however, many counties which did so. In only one state, Alabama, was there exhibited any of the old battle spirit of the pay-as-you-go vs. bond conflicts of a few years ago. Naturally and logically, bonding for road improvement is on the decline.

Highway Research—Under research in common highway parlance there come many activities from mere censuses to truly scientific critical inquiry. Literally scores of these counts and investigations are under way. They cover about all the common questions of road design, construction and operation. In a measure the Highway Research Board of the National Research Council is bringing them into co-ordination. Together they are each year extending a little the boundaries of information.

Foreign Roads—The meeting at Milan, Italy, of the International Road Congress and the very excellent news service on foreign road building being given by the Department of Commerce transportation division attracted exceptional interest in 1926 to foreign highway developments. In an engineering way, foreign practices give little that can be widely adopted in America. As possibilities for investment and as markets for contractors, materials and equipment, they have greater interest. If Americans are to go in for these opportunities, however, there is need of stricter engineering and business ethics than foreign road undertakings of the last twelve months have commonly displayed.

Routine Dominant—Every activity encounters at some period the hazard of falling into routine. This situation looms in highway improvement. There is good construction and maintenance and contentment in its ordered and intelligent routine. It is true that the routine task is large. Also it is true that here and there sounds a call of inspiration to greater purposes in highway development. There could not be entire lack of prescience. But the trend toward routine is the dominant one of official highway direction in 1926.

Excellent practices, be it recognized, distinguish this highway engineering routine. A large group of engineers has been trained in the technique of road improvement. There is a big body of contractors who specialize in highway construction and they can draw on a considerable supply of experienced workmen. Road building machinery is highly developed. The properties and uses of road construction materials are well known. Surveys are beginning to provide real knowledge of road traffic. With all these, public roads officials know how to locate, design and build well. They know how to maintain well what they build. They are performing all technical tasks capably in most cases, excellent in some cases, and poorly only in a few cases. In brief, good technique prevails, is the every-day routine, in road improvement.

THE CAMERON PASS HIGHWAY

By A. B. COLLINS
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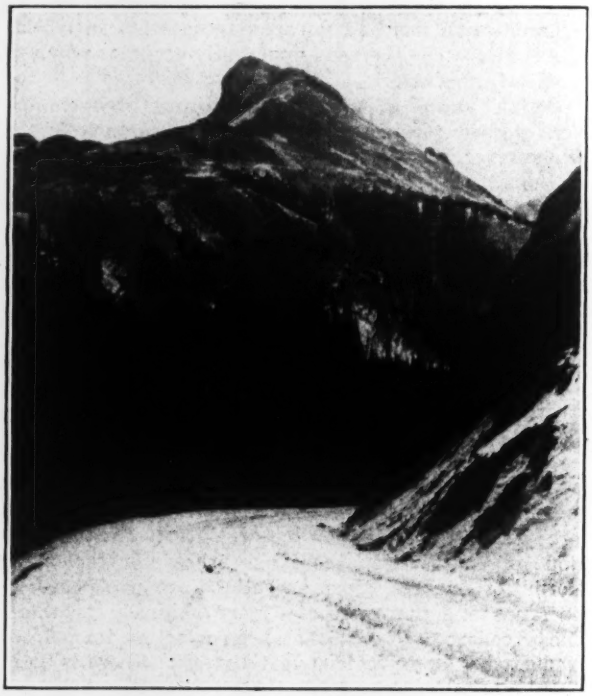
First Article of a Series Featuring, State by State, the Highway Developments of 1926 Awarded the Blue Ribbon of Distinction by the State Highway Engineer



OVER THE PASS IN VIEW OF THE SAW TOOTH RANGE

COLORADO

When the Cameron Pass highway was formally opened and dedicated in September, 1926, Colorado witnessed the fruition of fourteen years of unremitting labor. The splendid new highway has been completed through the combined efforts of the Colorado State Highway Department, Larimer and Jackson counties and the federal Bureau of Public Roads. Its completion is "a dream come true"; the dream of the late A. H. Edwards, first chairman of the Colorado State Highway Commission, who inaugurated a movement in 1912, for the construction of a road "up the Poudre River." The results have linked an intermountain empire, larger than the state of Delaware, with the outside world, by a scenic highway which is of unsurpassed beauty. —L. D. Blauvelt, state highway engineer.

THE DEVELOPMENT of east and west highways through Colorado is complicated by an almost insurmountable mountain barrier. The Continental Divide, the "backbone of the continent," crosses north and south through practically the center of the state. In establishing communication between the eastern and western portions of the state, any route selected must cross the divide.

In selecting locations, advantage is taken of those mountain passes of lowest elevation and least serious snow hazards. In this manner Colorado highways cross the Continental Divide at fourteen different passes, which range in elevation from 8,772 ft. to 12,095 ft. above sea level. The Cameron pass road crosses a spur of the main range less than ten miles from the junction of this spur with the main range, at an elevation of 10,200 ft. and is the seventh lowest of the passes across the mountains.

The road enters the Poudre Canyon at an elevation of 5,300 ft. and, attaining an elevation of 10,200 ft. in sixty miles, a maximum grade of 6 per cent has been obtained. The roadway is full 22 ft. in width and offers no hazards for even the most inexperienced of mountain drivers.

The first work on this road was performed in 1912 with funds raised by public subscription. At this time, sufficient funds were provided to extend a 14-ft. road a distance of approximately five miles through the lower reaches of the canyon. On the completion of this section of the road, Larimer County appropriated $24,000 with which to extend the work, and in the fall of 1912 contract was entered into for the construction of five additional miles, the work being conducted under the supervision of the Larimer County engineer. Before the completion of this contract, surveys were extended ahead, and in 1913 a route through the canyon was formally accepted as a state highway, and the Colorado state highway department became officially active in the construction of this road.

In the fall of 1913 the highway department with the co-operation of Thomas J. Tynan, warden of the Colorado state penitentiary, and the Larimer County officials, placed a working crew of 50 convicts in the canyon, a force which was maintained at joint state and county expense for eleven years until 1924.

The convicts selected for this work were "honor men," usually with short terms or terms which were within a few months of expiration. The selection of these men resulted in a heavy labor turnover, which impaired efficiency to some extent. It is interesting to note, however, that working without guards, there were only twelve or fourteen attempts to escape in a ten-year period, during which time only two convicts escaped en-

TYPICAL ROCK CUT OPERATION EAST OF WALDEN ON CAMERON PASS ROAD

tirely. In addition to other time allowances, the road work carried with it a deduction against sentence, of ten days for each month spent on the road. This, with the fact that infractions of camp rules and regulations resulted in the return of the offender to the penitentiary and the loss of earned time, was conducive to the maintenance of a reasonably efficient and tractable crew.

In conducting this work, center line stakes and grades were furnished, character of slopes, disposition of material, etc., being left to the judgment of practical road builders who had charge of the convicts. Handled in this manner, there are no reliable figures as to the yardage of material moved, but, comparing the costs per mile for finished roadway with those obtained by contract, it is evident that very appreciable savings were effected through the use of the convicts. This is particularly true through the solid rock areas, which constituted 60 per cent of the work, necessitating hand labor.

Maintaining a camp count of fifty men resulted in an effective working force on the road of about forty men, the balance providing for camp needs, such as cooks, flunkeys, laundrymen, wood choppers, and the sick list. The cost—sustenance, supervision, transportation—was $1.33 per day per man, resulting in an annual outlay for this purpose of approximately $24,000.

Powder for this work, consisting of sodatol, picric acid, and T.N.T., was taken from excess government stock at approximately 11c. per pound. An average of 30,000 lb. per year was used, with an indicated efficiency of approximately 1 lb. per cubic yard of excavation.

Over the work performed by the convicts, for a large portion of the way, lower slopes are held with dry rubble masonry. For this work Mexican convicts, who are adepts at rock wall work, were used exclusively.

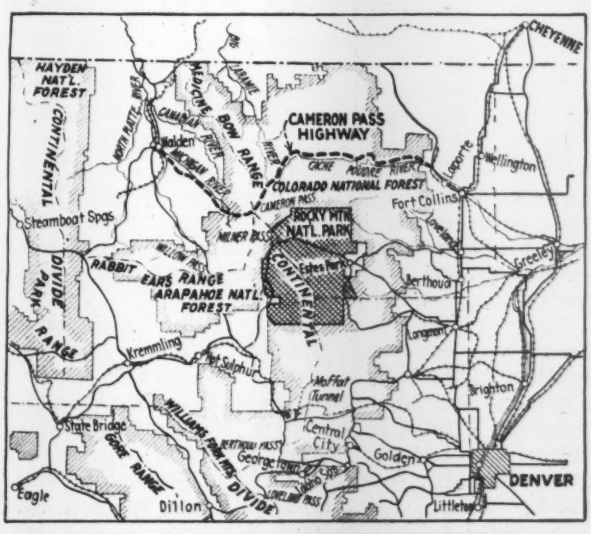
Between 1913 and 1924, the convicts advanced the road west through the canyon a distance of approximately fifty miles to a point about ten miles east from the top of the pass. At this point, Larimer County, through a reciprocal agreement with the state, assumed construction with county forces of free labor.

In the mean time, Jackson County, through state and county agreement, had constructed eastward from Walden up the Michigan River to the national forest boundary, about five miles west from Cameron Pass.

AT WEST END OF FORESTRY PROJECT

In 1923, a United States Forest project was initiated, which provided for the construction of 6.45 miles of standard 22-ft. forestry road from the end of the state and county work on the west, eastward over the pass. This section of the road was completed in 1926 at a total cost of $137,000. Simultaneously with the completion of this project, Larimer County completed the section westward ten miles from the convict work, at $80,000.

From its inception, until completion in September of 1926, in excess of $500,000 has been expended on this work, an expenditure more than justified by the economic returns assured through the completion of the project. For its entire length the road presents to the traveler an everchanging panorama of lights and shadows, open glades and box-like canyons with precipitous walls; at the side and below, the turbulent and crystal clear waters of the Poudre, while ever in front, until the pass is gained, the mountains rising majestically to the heavens present a never-to-be-forgotten picture. This everchanging panorama reaches its climax at the pass, where across the Michigan River, the Sawtooth Range with its many rugged peaks presents a view probably unsurpassed in the United States.



ROUTE OF NEW CAMERON PASS HIGHWAY

Highway Bridge Moved Without Interrupting Traffic

Four-Span Steel Structure, 400 Ft. Long, Is Jacked 15 Ft. Sideways While Vehicles Pass Over It Without Decreasing Speed

JUST east of Montebello, Calif., the Whittier Boulevard, one of the main trunk highways in southern California, passes over the Rio Hondo bridge. This structure consists of four steel truss spans, each 102 ft. long, and carries a roadway 24 ft. wide. Traffic over the bridge has increased to such an extent that decision was recently made to increase the roadway width at this crossing by the addition of a duplicate bridge.

To have left the existing bridge in place and constructed a new one alongside, would have thrown the resulting combined structure off the center of the right-of-way and also of the traveled way, putting a "kink" in the approaches at each end of the bridge. Moreover it would have required the purchase of additional right-of-way, the cost of which exceeded the cost of moving the trusses and roadway of the old bridge. For these reasons a contract was awarded for moving the old structure and building a new bridge alongside.

FIG. 2—ENDS OF TWO SPANS MOVING ALONG RAILS
Roller nest at left. Shoe at right is for a fixed end. Bedplates were slid directly on greased rails without rollers.

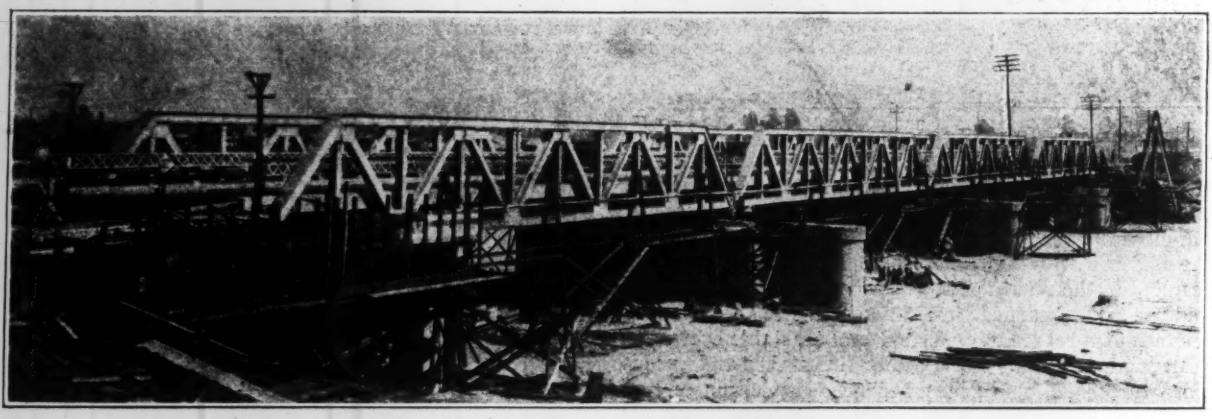


FIG. 1—THE RIO HONDO BRIDGE PARTLY MOVED
Bridge roadway is 9 in. above normal position. Timber approach apron moved along with the bridge.

Traffic checks showed a daily average of 15,000 vehicles over the bridge and the only practicable detour was about 3 miles long. Figuring an operating cost of 7c. per mile the cost of this detour to the motoring public would have been $2,500 per day. The original contract allowed ten days for moving the bridge, contemplating that traffic would be detoured while each span was being moved separately. However, an idea was developed, for which credit goes to the contractor, whereby the width of the old piers having been extended 15 ft. upstream under the original contract, all four spans could be simultaneously moved sideways this distance without in any way interfering with traffic. If travel had been diverted over the detour for ten days, the detour cost to traffic would have been about $25,000 whereas the additional cost of the contractor's plan for moving the bridge as a unit, without interrupting traffic, was only $2,500.

The trusses were moved by first placing under the bottom chord near each shoe a structural steel lifting leg supported on 75- and 100-ton gear-jacks which lifted the four corners about 9 in. so two lines of 60-lb. rails could be placed transversely under each end of the spans. From the old piers the rails were continued out over the pier extensions built on the upstream side to which it was desired to move the bridge. The rails were well greased and at their downstream ends kick blocks were bolted on to afford a bearing against which the jacks could thrust in moving the bridge upstream. After the four trusses had been gradually but simultaneously moved as far as was desired, the lifting legs were again set beneath the bottom chords, the weight was lifted while the rails were removed and then the spans were lowered to final position. As the trusses came down, anchor bolts were dropped into specially prepared holes in the concrete and grouted in place by pouring through a groove left under the shoe for that purpose.

In preparation for placing the lifting legs by which the four corners of each span were raised, two 10x16-in. timbers, 14 to 16 ft. long, were embedded in the sand of the dry river bed on an area that had been thoroughly puddled. With this preparation a maximum settlement of only 2 in. took place before the bridge began to lift. The lifting leg consisted of an 8-in. H-column bolted at the top to a 15-in. I-beam on the top of which in turn was riveted a 12-in. channel, flat side up. Stiffeners

were bolted to the web of the I-beam to prevent buckling at the point where the load was greatest.

Oak filler blocks were placed between the lifting girders and the two 12-in. channels which constituted the

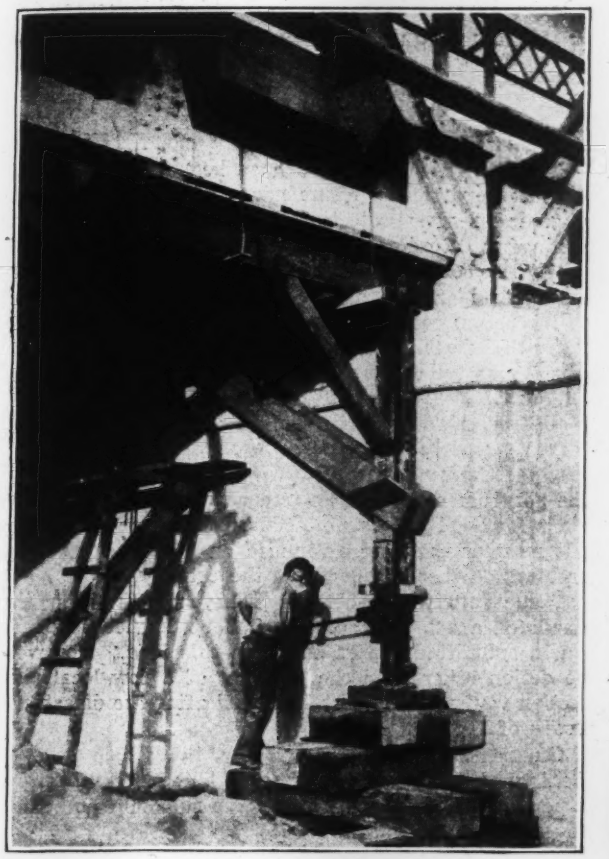


FIG. 3—LIFTING LEG UNDER BOTTOM CHORD NEAR SHOE

Note offset over top of pier and stiffeners to prevent buckling of web over jack. Also combination "half-trestle" and ladder.

bottom chord of the bridge. These blocks had depressions cut out to fit over the rivet heads both above and below and were expected to prevent any slipping which might have resulted had the two steel surfaces been brought together. In order to lift the bridge in this way without injuring the structure it was found necessary to throw the greatest part of the load into the rivets near the pin. For this reason the lifting girder was carried over the pier top as far as possible.

To prevent the lifting legs from kicking out transversely to the bridge, wooden braces were used as shown in the illustration. The "half-trestle" type of staging also shown is said to have been a real convenience, being used by the men who wedged up the shoes, by those who burned off the bolts and to afford access here and there for adjustments and inspection as the work progressed.

Passing vehicles, especially loaded trucks representing live-loads up to 12 tons, caused a decided vibration in the structure, particularly when one span was being lifted slightly in advance of another. This vibration was anticipated and for this reason more than any other, only one end of each span was lifted at a time, the other end remaining fixed until the end lifted had its weight transferred from the lifting legs. Side sway as much as ½ in. was noticed at times but since the space between the top of the pier and the bottom of the shoe was kept blocked up as the lifting progressed the sway caused no alarm. As a further precaution the sections of rails, as they were pulled under the shoe, were permitted to push the blocking out ahead of them.

The kick blocks consisted of two 12-in. steel channels with wood fillers between, the whole assembly being firmly attached to the rails below by three inclined ¾-in. bars on either side of the block, held in place by 1-in. bolts. This three-bolt design withstood all thrusts except at one end span where irregularity of the joint caused excess friction so that a 75-ton thrust had to be used. This failure, however was due to the use of short bolts; longer bolts, in which the shear was not on the threaded section, withstood the strain.

The shoes had been anchored to the piers with 1½-in. bolts; these were burned off as the lifting began. The fixed shoes rested on blocks of cast steel filled with 8 in. of concrete through which the anchor bolts passed. To break the bond between these four anchor bolts and the concrete, steel wedges were driven under the shoe as the lifting proceeded.

The weight of each bridge span, including the 10-in. concrete floor and 1½-in. asphalt surface, was calculated to be 258 tons, to which an estimated live-load of 42 tons was added, making a total per span of about 300 tons, or 75 tons on each shoe. Taking the friction coefficient as 0.11, the thrust required at each end of each span was calculated in advance to be 150x0.11, or 16.5 tons. In the actual moving, however, it developed that the thrust required to start the load was not

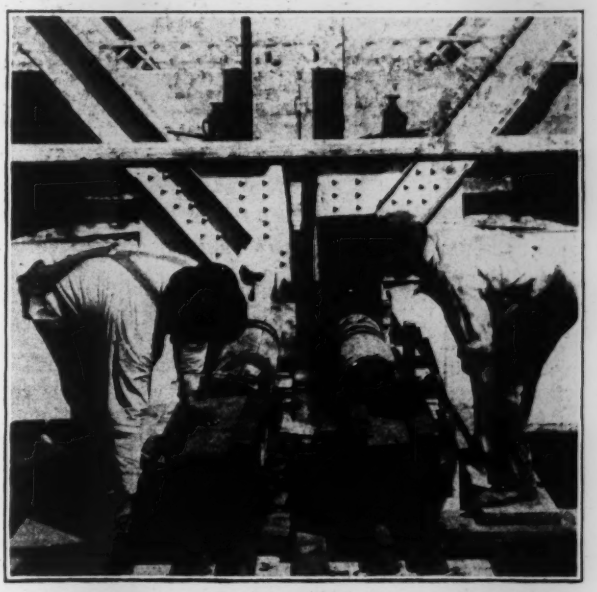


FIG. 4—STARTING THE JACKING, KICK BLOCKS IN FOREGROUND

The large gear jacks shown in operation were used only at starting. Once started the small hydraulic jacks shown in Fig. 3 were used.

infrequently 40 to 50 tons, and at the end spans, where it was difficult to avoid friction against the abutting concrete, as much as 75 tons was required. However, the actual friction after the moving was well started in most cases was only about 17 tons.

After the bridge had moved a few feet small

hydraulic jacks were substituted for the gear-jacks used at the start. These small jacks were convenient to handle and could be operated rapidly but were capable of moving only 5 in. without resetting. The maximum speed during the entire moving process was 22 in. in one hour uniform movement of all four spans.

Because the jack resettings had to be made frequently and because they could be accomplished quickly, no attempt was made to synchronize each stroke at the several jacking stations. Nevertheless, excellent teamwork was obtained, resulting in practically uniform advance at all the piers. Whenever one station moved too fast the expansion joint between spans, averaging about 1 in. in width, would close, thus preventing that station from pushing the bridge any farther until the rest of the structure had caught up. Measuring sticks were nailed to the ties at each pier on which feet and

FIG. 5—STEEL BENTS REINFORCED PIER DIAPHRAGMS

inches were noted, thus making possible a constant checking of relative advance at the jacking stations.

Only one jack was used for each end of each span, and in order to transmit the load directly from one side of the bridge to the other, 8x8-in. timbers were wedged between the two shoes, relieving strain at the pin connection.

At the time the work was under way the rush-hour traffic had become so heavy that even without speed restrictions the traffic capacity of the bridge was being taxed. It was therefore highly desirable to accomplish the moving without placing any restrictions upon vehicles crossing the bridge. Under the plan adopted no restrictions were necessary and during the entire moving process traffic passed over the bridge continuously, often at speeds approaching 40 miles per hour.

The contract for moving the old bridge and erecting the new structure was held by Gutleben Brothers, Los Angeles, Calif., and was carried out under the personal supervision of C. T. Gutleben. Lawrence Sovulewski was resident engineer for the contractors. For the California Highway Commission, A. S. Kennedy was resident engineer; S. V. Cortelyou is division engineer under R. M. Morton, state highway engineer.

Sea Flood Control Planned for Leningrad, Russia

Dams Across Neva Bay Basis of All Schemes to Guard Against Strange Phenomenon of Floods from the Finnish Gulf

By V. E. Liakhnitsky
Professor of Civil Engineering School at Leningrad

THREE general projects have been proposed by an interdepartment commission of city and state officers for the protection of parts of the city of Leningrad, Russia, from periodic inundation. For nearly two centuries there has always been some scheme under consideration, but few of them have been carried to the actual construction stage. In the early days of Peter the Great, plans were drawn to dig a net of channels across the city area in order to facilitate the flow of Neva River water into the bay which was thought to be the contributing cause of the floods. Some of these channels, existent now, were built later during the reign of Catherine II. Following a great flood in 1824, the government opened an international competition on plans for flood protection. Many plans were submitted, but most of them were founded on the old and wrong assumption that the floods in the estuary of the Neva are due to river discharge. They are, in fact, the result of a sea wave, and a famous French engineer Bazin submitted a plan based on this idea. However, no action other than the building of a few local protection works was undertaken until after the disastrous floods of 1924.

On Sept. 23, 1924, practically the whole city of Leningrad, with an area of some 50 square miles and a population of over a million, was suddenly inundated to an average depth of 5 to 7 ft. Since the flood occurred in the daytime there was practically no loss of life. It followed directly as a result of this flood that the interdepartment commission, composed of meteorologists, hydrologists and civil engineers, was formed. This commission has agreed that the cause of the floods is from a sea wave and the plans it proposes are based on this assumption.

Origin and Nature of Sea Floods—The accompanying map gives a picture of the physical conditions in and around the city of Leningrad and Neva Bay. The Neva River is 40 miles long with headwaters at Lake Ladoga. It enters the Finnish Gulf of the Baltic Sea through a delta of five arms, upon which is located much of the city of Leningrad. Neva Bay is a shallow basin with an area of 350 sq.km. (135 square miles), sheltered from the Finnish Gulf by Kotlin Island. The length of the gulf from Kotlin Island to the open Baltic Sea is about 350 km. (218 miles).

The meteorological process which precedes the floods begins as a cyclone in the north portion of the Atlantic Ocean. Traveling east, it crosses the Scandinavian peninsula and the Baltic Sea, sometimes turning to the south and sometimes passing straight into the Finnish Gulf. Under the influence of this cyclone there occurs a general rise of the Baltic Sea which is reflected in the Finnish Gulf. Since the latter has a funnel shape, the height of the wave coming from the Baltic increases gradually as it approaches the city. Although the rise in sea level may be only 2 or 3 ft. at the mouth of

the Gulf, it at times may become 10 to 14 ft. when it reaches the city. Since Leningrad is only 6 to 10 ft. above mean sea level, such rises cause a considerable inundation of the city.

The following hydrological statistics have been collected over a period of 200 years:

Sea Level Rise in Neva Estuaries	Period of Occurrence	Sea Level Rise in Neva Estuaries	Period of Occurrence
13½ to 14 ft.	100 years	5 ft.	1-1½ years
9 ft.	20 years	4 ft.	3 times annually
8 ft.	15 years	3 ft.	4 times annually
7 ft.	9 years	2 ft.	10-15 times annually
6 ft.	4 years		

The highest flood recorded was in 1824, the water rising to 13 ft. 8 in. For 1777 a flood height of 10 ft. 7 in. is recorded. The flood of 1924 reached a level of 12 ft. 7 in.

Present Schemes for Flood Protection — The inter-department commission has proposed three general schemes for flood protection, but only after an extensive field survey and a study of the economic factors involved can it be determined which of these is the best.

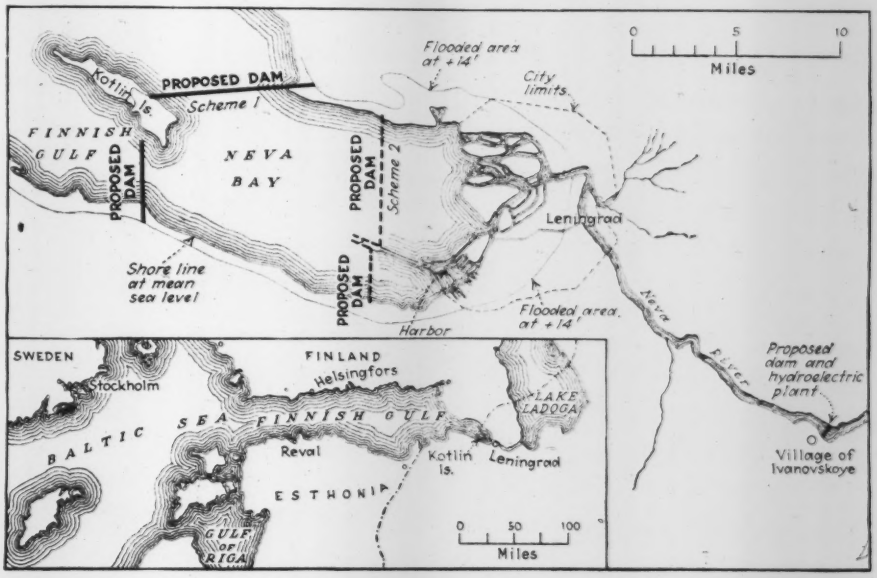
The dams which form the basis for each of the proposed protection plans are shown on the map. The first one, which can be called the "sea project," involves the building of two dams between the shores of Neva Bay and Kotlin Island the northern dam being from 5 to 15 ft. high and 7½ miles long, while the southern dam would vary in height from 3 to 6 ft. and be 3½ miles in length. Spillways protected by gates would be constructed in both dams to permit the passage of Neva River waters into the sea. A navigable pass would be constructed in the southern dam, also protected by a gate, or else constructed as a lock. If this plan should be followed the Neva River waters which come into the bay at the rate of 4,500 cu.m. per second will produce a rise of 2 ft. during the longest flood period ever recorded, which was 20 hr. Such a rise which occurs from 10 to 20 days in the year does not affect the city and its surroundings.

The second scheme would include only one dam across the bay, situated approximately halfway between Kotlin Island and the city. This dam, varying in height from 5 to 10 ft., with a length of 8 miles, would also have to be equipped with spillways and a navigable pass with a gate or a lock. There would be an area of approximately 50 sq.mi. of bay behind this dam.

Although the single dam would be cheaper to construct than the two dams of the first scheme, there is a much smaller area for the accumulation of river discharge in time of floods when all outlets in the dam are closed. Under such a condition the Neva estuaries would probably rise from 5 to 7 ft., which would inundate small sections of the city. In other words, protection from sea floods would result in river floods. To decrease the danger from river floods, it is proposed, in connection with the second scheme, to build a river dam in order to check the river discharge during the time of sea flood. The location of this river dam is suggested at 14 miles above the city, at a place where it may be combined with a hydro-electric plant.

The third scheme, which can be called the "estuary scheme," involves the building of high dams running along the shore lines of the islands. Spillway outlets and a navigable pass are essential as in the other two plans. The length of the dams for this plan will be even greater than in the first two schemes, but on the other hand they can be constructed under more favorable foundation conditions and will not be so exposed to the violence of the sea wave. The river dam upstream becomes a quite inevitable part of the third scheme, as it is of the second.

It is a question of further study, field surveying and plan drawing in order to decide which of the three mentioned schemes is the cheapest and best from an engineering standpoint. The duties are now being undertaken by the inter-department commission.



FLOOD PROTECTION PLANS PROPOSED FOR LENINGRAD

World's Largest Artificial Reservoirs

With completion of Martin dam, of the Alabama Power Co., with its enormous artificial lake, considerable interest has been aroused in the relative size of the larger artificial reservoirs of the world. The world's largest artificial reservoir is on the St. Maurice River in the Province of Quebec. The larger reservoirs, in order of magnitude, are as follows:

Reservoir	Capacity, Cu.ft.
Gouin, St. Maurice River, Quebec	160,000,000,000
Elephant Butte, New Mexico	114,911,000,000
Assuan, Nile River, Egypt	91,800,000,000
Roosevelt, Salt River, Arizona	71,321,000,000
Martin Dam, Tallapoosa River, Alabama	70,800,000,000

The American Falls reservoir in Idaho will have a capacity of 74,052,000,000 cu.ft. when the dam has been built to its full height.

Rock Asphalt Road Construction with New Devices

Short Construction Period Called for Quick Tests and Special Construction Devices—Curb Forms Improved—Corrugating and Spray Painting to Bond the Asphalt to the Concrete

By W. L. Moore
Resident Engineer, State Highway Department, Nashville, Tenn.

A NOTABLE highway with rock asphalt surfacing will be completed from Nashville, Tenn., to the Kentucky line with the construction, now in progress, of five miles of the old Gallatin pike. This work involves a new grade and a 7:5:7-in. concrete base with a 1½-in. Kyrock surface between 1½x9-in. curbs. The drawing shows the section, and this article deals specifically with its construction. There was, however, a notable grading task. Much of the grading required blasting through shelf rock with consequent earth backfill to secure the necessary cushion for the concrete. It involved the removal of 40,000 cu.yd. of material.

The contract was let to S. M. Billiter in June, 1926, and the contractor placed an excellent organization on the work. The very latest in equipment is being used and the work has progressed with very little interruption from breakdowns. Indeed the progress that has been made could not have been made with the degree of accuracy that has been obtained if we had not had an organization so well equipped. To the date of taking the accompanying photographs, Oct. 19, 1926, although delayed more than five weeks by rains, the contractor graded practically 90 per cent of the total project, laid 2½ miles combination cement concrete base and edging and 2 miles of the surface course.

STANDARD SECTION OF ROCK ASPHALT ON CONCRETE

Expediting Test Reports—To accomplish this good progress it was necessary that we devise some means of expediting test reports; the railroad company, at economical haul points, was unable to assign sufficient storage space to enable the department to render the usual 7-day strength ratio test reports. Each item of material is tested, but to avoid delays and demurrage to the contractor we evolved the scheme of plotting a graph of ratios between the gradation and strength test for 100 previous reports on the same material. Thus by running the gradation test on a new consignment, and then consulting the graph we could immediately accept or reject material.

Improved Curb Forms—The base was laid with a 9x1¼-in. curb formed monolithically—that is, as near monlithically as we have been able to evolve a scheme so to form it. Immediately following the final finish with the machine, forms are laid to form the curb; thus the curb construction follows but a few feet behind the mixer. At first a very tedious procedure was followed. Forms were made of wood, bolted fast to the regular pavement form with the inside form connected by a rigid strap iron, arched to permit the edger to pass beneath. After the first mile of pavement was laid it was decided to use angle irons. As 1¼ in. height is not standard stock, angles 1½x1½ in. were planed down on one side to meet the design. By adopting this method considerable saving was effected, inasmuch as the weight of the angles was sufficient to hold them in place with only drop pins through the pavement form for alignment. The inside form was spaced by U-straps only, and this permitted their quick removal.

Widening Finishing Machine—Another interesting feature was increasing the 20-ft. finishing machine to 24 ft., as the first two miles of the project were 24 ft. and the remaining 3½ miles were 20 ft. in width. This was accomplished by the purchase of new channels for the main frame and by splicing the I-beams and screed boards. This work was done in a local machine shop at a cost of approximately $150. This item is negligible when compared with the costly and unsatisfactory methods of hand finishing and should be interesting to all contractors faced with similar conditions, whenever the amount of work involved does not warrant the purchase of two machines.

Machine-Finished Corrugated Surface—While it is well known that bituminous tops are successfully laid on smooth-finished concrete, practically all of such cases are repair jobs or surfacing jobs made necessary by the disintegration of smooth slabs not originally designed for an asphalt top. And, while the asphalt top apparently clings to the smooth-surfaced slab without subsequent slippage, and, further, while the material we are using is laid extensively over smooth slabs, we nevertheless determined that a roughened slab surface would make a better job for the retaining of the asphalt top. How to obtain it with the finishing machine without the addition of hand work was an interesting problem. In finishing the base with the finishing machine we did considerable experimenting to get the true grade for riding qualities, that is, true to cross-section and profile and still obtain from the same operation the roughened surface most desirable upon which to lay the surfacing.

After trying various expedients we discovered that, by drawing the back lift chains of the finishing machine slightly taut, a slight irregular corrugation was produced on the surface of the base. This furnished

Construction Methods in Laying Rock Asphalt on Concrete

SETTING FORMS ON GRADED SUB-BASE IN ADVANCE OF MIXER

ANGLE-IRON FORMS FOR CONSTRUCTION OF 9x1½-IN. INTEGRAL CURB

CORRUGATED SURFACE PRODUCED MECHANICALLY BY TIGHTENING LIFT CHAINS ON REAR SCREED BOARD OF FINISHING MACHINE

SPRAYING CONCRETE SURFACE WITH 60 PENETRATION CUTBACK ASPHALT PAINT BEFORE APPLYING KYROCK

SHOVELING AND RAKING KYROCK WEARING SURFACE—CREW PLACED 1,000 TO 1,200 FT. OF 24-FT. ROADWAY PER DAY

IMPROVISED STORAGE AND LOADING EQUIPMENT AT EDENWOLD—LONGEST HAUL TO MIXER, 3½ MILES, OVER ROAD BEING GRADED

the ideal surface for receiving the rock asphalt top. As the asphalt-top concrete road is coming into general popularity in many states this should prove interesting to contractors specializing in this class of construction, as it eliminates the cost and time of hand work following the finishing machine and does a much more uniform and thorough job.

Applying the Spray Paint Coat—This project was let without a paint coat application in the specifications, and doubtless the degree of roughness obtained in the concrete surface with the shortened stroke of the screed board would furnish sufficient bond for the asphalt wearing surface but, after consultation with the division engineer, I secured permission to paint the base. For this purpose we used a hand force-pump mounted on a reservoir which was in turn mounted on an ordinary quarry car. With this outfit a paint coat of 60 penetration asphalt is sprayed on the base and the paint coat is applied only far enough ahead of the rakers, temperature considered, to give the cut-back gasoline time to evaporate and yet leave the asphalt paint wet and with proper adhesiveness for the wearing surface.

Rolling the Top—In rolling also we departed from the letter of the original specifications, which required that the bituminous top be rolled for six consecutive days. The contractor who was familiar with the characteristics of Kyrock, the material we are using, demonstrated that its surface is not improved by repeated rolling. This material, a natural rock asphalt, laid cold, takes an initial bond under the first rolling, which does not noticeably alter under subsequent rollings. Cross rolling would not iron out inequalities in the surface due to imperfect distribution with the rakes, as is the case with sheet asphalt. We found that using reasonable care in the raking and rolling twice with an 8-ton tandem roller produced a better job than the repeated rolling required by the original specifications. This released the road to traffic several days sooner than ordinarily would have been possible under the letter of the specifications, as we turned all pneumatic-tired traffic over it after the second rolling and found it beneficial in the final ironing out. We experienced no difficulty with the ordinary road crew in manipulating this material, eight shovelers and four rakers laying 1,000 to 1,200 ft. of 24-ft. roadway per day.

Storm Reopens Old Beach Inlets

Three old inlets to Miami Beach, opposite Miami, Fla., were reopened by the tide and ocean current effects in the hurricane of September 18, according to the report of a committee of the Palm Beach Engineers Association which recently made a report on storm effects. The Sub-committee on Seawalls and Waterfront, consisting of J. M. Boyd and A. O. Taylor, says of this effect: "A most unusual phenomenon occurred in connection with the old inlets on Miami Beach, three in number, which had been filled in. In one case a house had been built on the filled-in ground. In a second case the inlet was filled in with no structure on it, and in the third case (Baker's Haulover) the inlet was constricted and a bridge built across it. All three of these old inlets were washed through by the storm, the waters following their old courses, undermining and breaking the house in the first case, washing out all the fill ground in the second case, and, in the third washing out both approaches to the bridge."

Maintenance Costs of Brick Roads in Cuyahoga County

Cost of Upkeep from One to Twenty-One Years on Two Million Yards of Brick Roads with Heavy Traffic

THE causes chiefly responsible for maintenance costs according to a survey of paved road maintenance records in Cuyahoga County, Ohio, are: *For rigid types,* (1) unstable subgrade, inadequately drained and (2) weak, inferior bases. *For non-rigid types,* (1) under design, i.e., cutting the thickness to obtain low first cost, and (2) placing inferior types of pavement on roads where traffic and soil conditions demanded a better type. These conclusions are the outcome of a study made by Frank A. Thomas, former paving engineer of Cuyahoga County and reported to the American Society of Municipal Improvements at its convention of Nov. 8-12, 1926. A condensation and partial restatement of the report is presented here. In introduction it may be said that the paved rural roads of Cuyahoga County aggregate nearly 400 miles, made up of 140 separate improvements and four main types as follows:

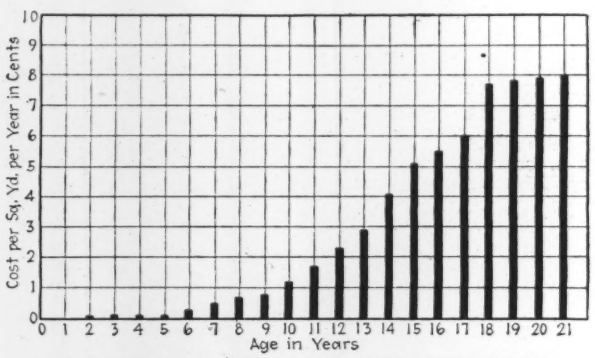


FIG. 1—REPAIR COSTS OF ALL BRICK PAVEMENTS FROM 1 TO 21 YEARS

Type	Sq.Yd.	Per Cent
Brick	2,058,399	65
Concrete	592,213	18
Macadam	349,284	11
Asphalt	208,361	6

Outstanding are the brick pavements. Some of these were built as far back as 1896 but the records here considered cover ages up to 21 years. The essential structural characteristics are:

Item	Per Cent
Brick, thickness 4 in.	96
Brick, thickness 3 in.	4
Cement grout filler	91
Asphalt filler	9
Plain sand or granulated slag cushion	87
Cement-sand, 1:3 mix, cushion	3
No cushion, laid direct on green concrete	10
Broken stone base, 6-in.	18
Concrete base, 4-in.	63
Concrete base, 5-in.	7
Concrete base, 6-in.	4
Concrete base, 7-in.	7
Concrete base, 8-in.	1
Concrete base reinforced	12
Stone curbs	25
Concrete curbs	75

The group of cost graphs, Figs. 1 to 4, are for these brick pavements. They are for slab maintenance only. They were determined by taking the amount of money spent for repairs on the several improvements each year and dividing that amount by the total yardage in service during each year. The result was the repair

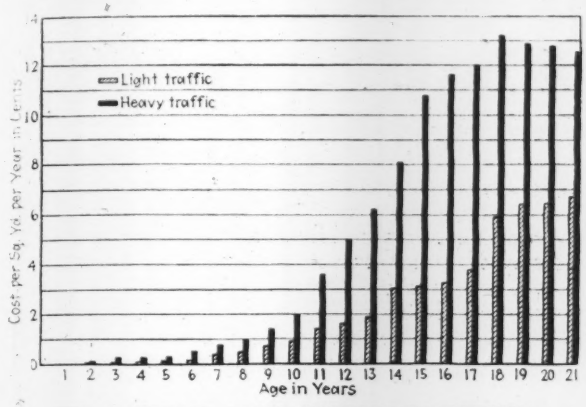


FIG. 2—REPAIR COSTS OF BRICK PAVEMENTS FOR LIGHT AND HEAVY TRAFFIC

cost per square yard for each year. The cost per square yard per year is the quotient of the accumulated amount of money spent for repairs in any period of years, divided by the number of years in that period.

As an example, says Mr. Thomas, there were 2,058,399 sq.yd. of brick pavement that were in service one year, on which nothing was spent for repairs, making the cost per square yard for the first year nothing. There were 1,898,227 sq.yd. that were in service two years, on which was spent the sum of $2,753, making the cost per square yard for the second year 0.14 cent. There were 1,875,359 sq.yd. that were in service three years, on which was spent the sum of $4,222 during the third year, making the cost per square yard for the third year 0.22 cent. Now the accumulated cost per square yard for three years is the sum of nothing for the first year, 0.14 cent for the second year, and 0.22 cent for the third year, or a total of 0.36 cent. The cost per square yard per year for a three-year period would be 0.36 cent divided by 3, or 0.12 cent.

Fig. 1 is a graph showing the repair cost per square yard per year for all brick pavement regardless of the type of construction or location, and cover an experience of 21 years in rural highway paving in a rapidly growing locality. The repair cost is low and rises gradually for the first ten years, after which it rises rapidly and in the twelfth year has doubled; in the fourteenth year it has quadrupled; and in the eighteenth year it is eight times as much. Quoting Mr. Thomas, "It is noted that this period of sharp rise in repair costs starts at about the time that the gasoline motor brought to streets and highways an intensity and weight of traffic never anticipated by the engineers who designed them."

Fig. 2 shows the repair cost per square yard per year for brick pavements carrying light and heavy traffic respectively. The decision as to which are heavy or light traffic pavements was made from personal knowledge and from whatever traffic data were available. Fig. 3 shows the repair cost for pavements built between 1915 and 1925, and Fig. 4 the cost for pavements built on a 4-in. concrete base.

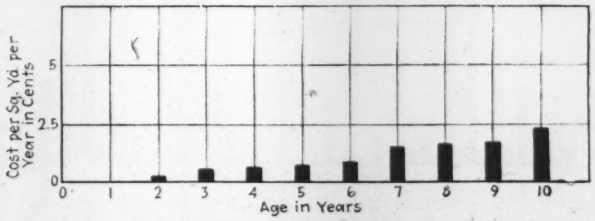


FIG. 3—REPAIR COSTS OF RECENT BRICK PAVEMENTS (1915-1925)

One half of the total repair cost was spent on the pavements built between 1904 and 1909. These pavements have a non-rigid base of broken stone 6 in. thick and the yardage is 18 per cent of the total. Two-thirds of the total repair cost was spent on seven roads having less than 20 per cent of the total yardage. These were the heaviest traveled of the brick roads. The repair cost on these seven roads equals 90 per cent of their initial cost. One half of the total repair cost was spent in the twelfth, thirteenth, fourteenth and fifteenth years.

Several of the old brick pavements this year (1926) are being reconstructed by widening and resurfacing, and in these cases it is possible to determine a salvage value, and the total pavement cost per square yard per year of the pavement. One pavement in particular is being resurfaced with asphaltic concrete. The original cost of the old brick pavement was $1.81 a square yard. It has given 20 years of service with a repair cost of $1.60. The interest for 20 years at 5 per cent is $1.81, making the total cost $5.22. The salvage value or the worth of this old pavement as a base is at least $1.75. The net cost will be the difference or $3.47 for 20 years of service or 17.4c. a square yard per year. At this rate an 18-ft. pavement would cost less than $2,000 a mile per year.

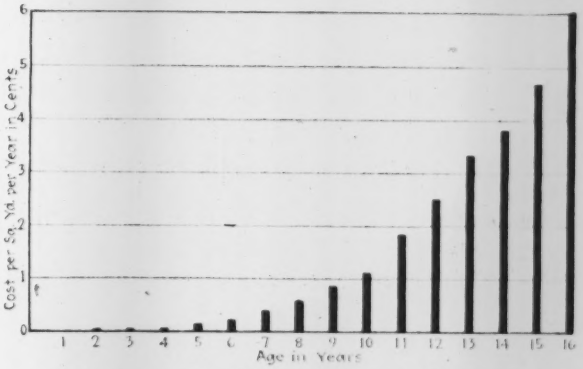


FIG. 4—REPAIR COSTS OF BRICK PAVEMENTS MONOLITHIC WITH 4-IN. CONCRETE BASE

The pavements that required the most repairs were the heaviest traffic routes, on clay soils, which had a low supporting value. Faulty drainage undoubtedly was the major cause of many of the repairs.

The average original cost per square yard for all brick pavements built between 1915 and 1925 was $3.42. Since two-thirds of the brick yardage was built prior to 1915 on a 6-in. broken stone or 4-in. concrete base, only 14 ft. wide, and was designed primarily for horse-drawn vehicles, these brick pavements have a very reasonable repair cost. The brick pavements built from 1915 to 1925 have a lower and more uniform repair cost.

In Cuyahoga County, pavements have been financed by 10-year bonds and any pavements that require excessive repairs during this period may justly be considered a failure. There were no failure in brick.

There is no doubt but that the grout filler in the brick surface added greatly to the strength of these old pavements with thin weak bases, and was one of the reasons why they stood up so well.

Government Statistics of Road Construction From 1904 Through 1925

THE following four pages present for the first time a tabulation of total and surfaced road mileages in each state for each year since 1904, with charts interpreting trends. These figures were compiled by *Engineering News-Record* from the records of the United States Bureau of Public Roads. They include the state highways, and the county and local rural road mileage, as gathered and compiled by the Bureau.

CHART I
Distribution of Mileage by States

The 3,001,825 miles of rural roads in the United States are here shown by states. The black portion shows the mileage of surfaced roads. In order to get an idea of the changes that have taken place in the last twelve years, see Chart II below.

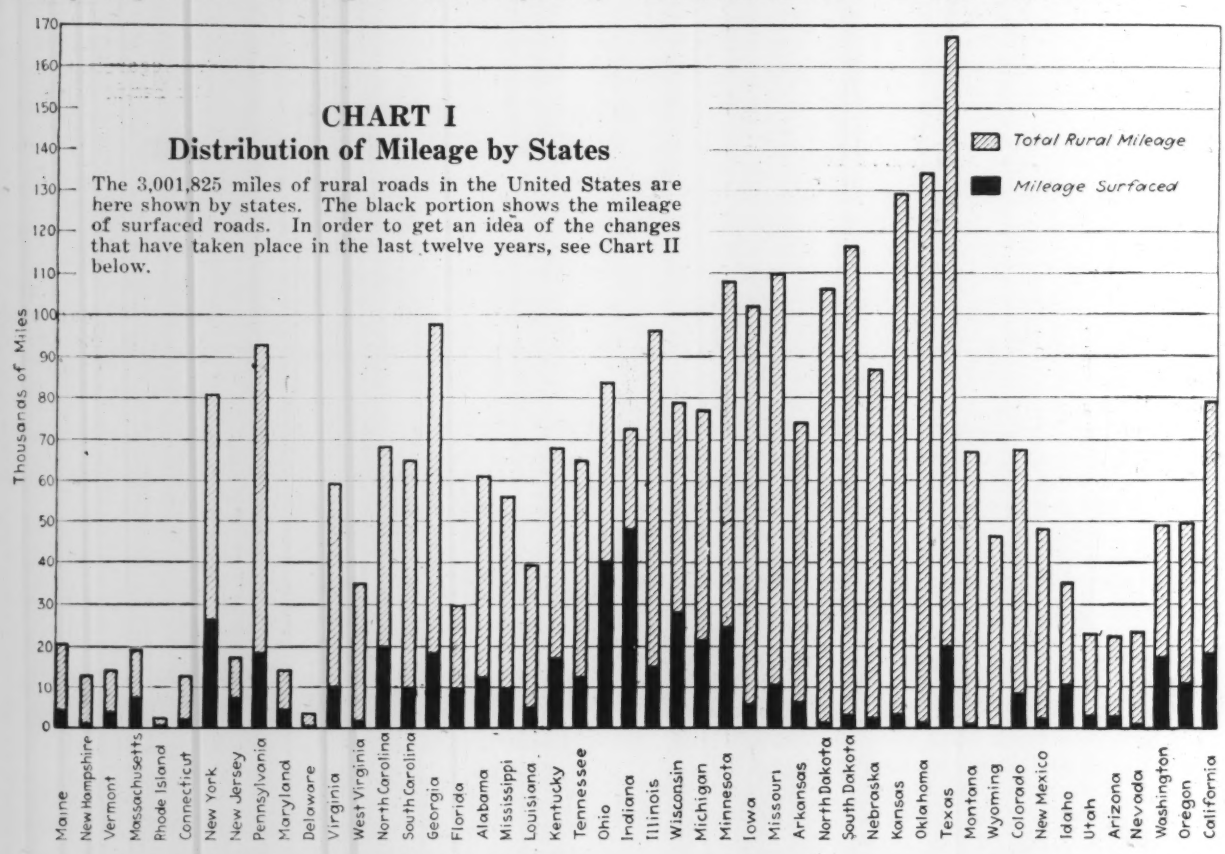


CHART II—Changes Since 1914

The hatched bars show the per cent increase or decrease of rural mileage, and the black bars show the same for surfaced road. New England's total mileage decreased 3 per cent since 1914. The Middle Atlantic and Middle Western States show an increase of only 2.5 and 1.5 per cent, respectively. It is in the newer sections, the states west of the Mississippi and beyond the Rocky Mountains that the largest increases have naturally taken place. These states will probably continue adding to their road mileage for some years to come.

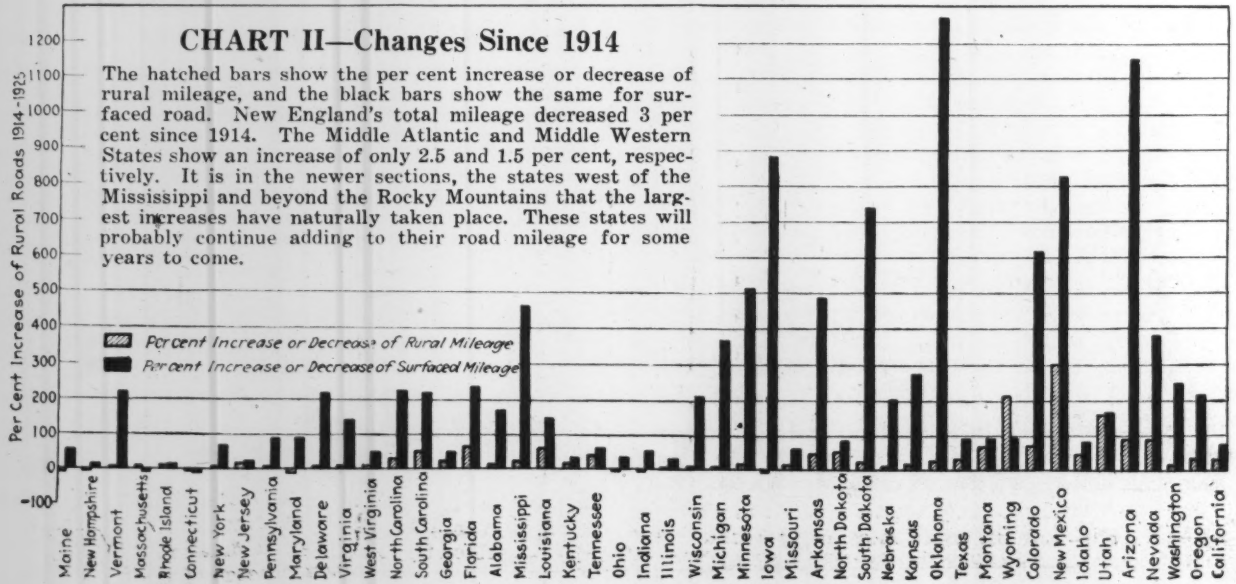


CHART III

Type Trends—1914 Compared With 1925

Chart III gives the percentage of the different types of surfaced roads in 1925 as compared to 1914. The tendency toward the more expensive type of road is evident. The cement concrete roads, which formed a negligible part of the total in 1914 increased to 7.3 per cent in 1925. Although brick and bituminous concrete form a small part of the total surfaced mileage, they nevertheless serve to show what the trend is. Of the cheaper grades, sand, clay, and macadam have decreased while gravel shows an increase.

CHART IV

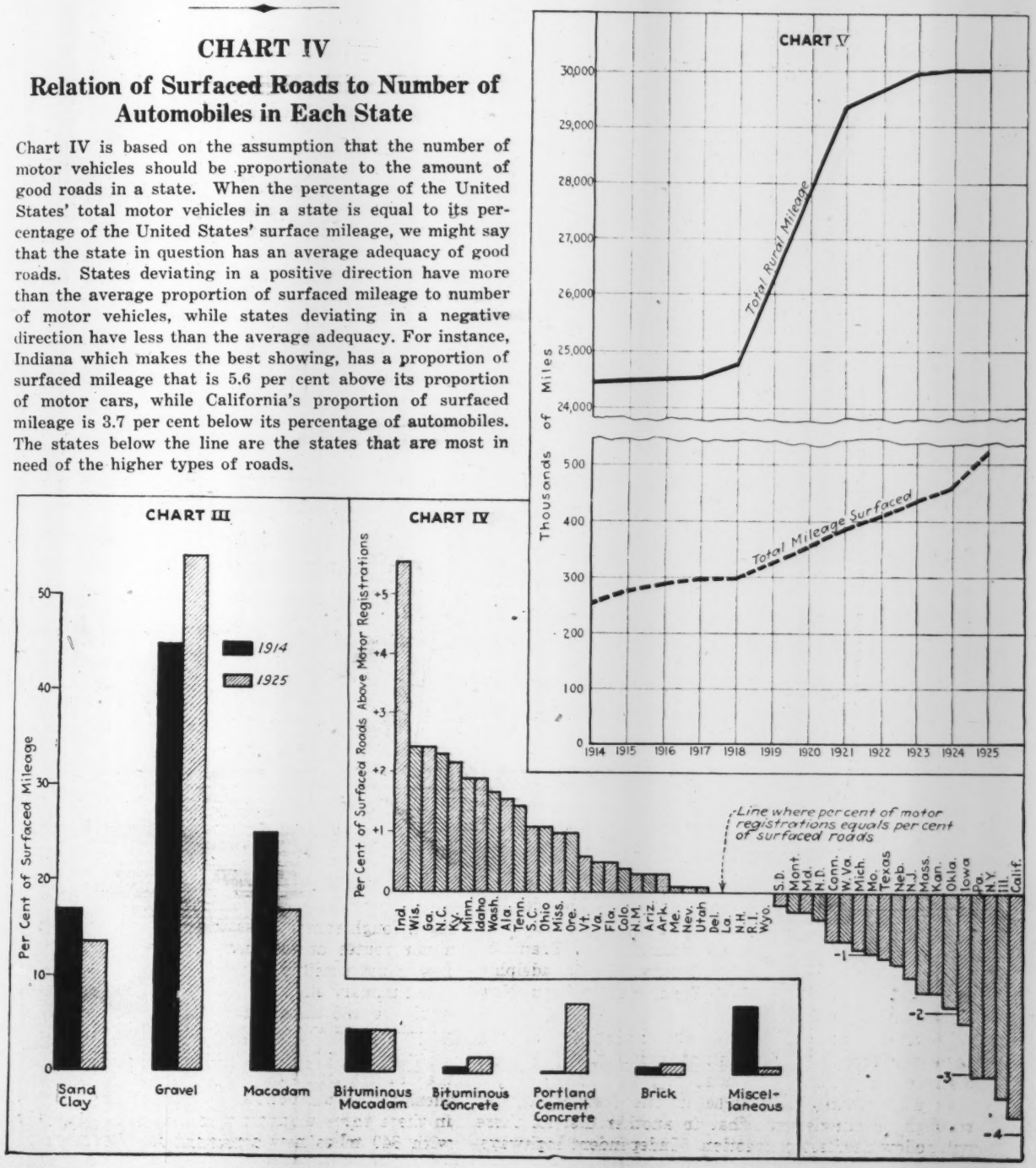
Relation of Surfaced Roads to Number of Automobiles in Each State

Chart IV is based on the assumption that the number of motor vehicles should be proportionate to the amount of good roads in a state. When the percentage of the United States' total motor vehicles in a state is equal to its percentage of the United States' surface mileage, we might say that the state in question has an average adequacy of good roads. States deviating in a positive direction have more than the average proportion of surfaced mileage to number of motor vehicles, while states deviating in a negative direction have less than the average adequacy. For instance, Indiana which makes the best showing, has a proportion of surfaced mileage that is 5.6 per cent above its proportion of motor cars, while California's proportion of surfaced mileage is 3.7 per cent below its percentage of automobiles. The states below the line are the states that are most in need of the higher types of roads.

CHART V

Total Rural Road Mileage Compared With Total Mileage Surfaced

Chart V compares the trend in total mileage with the trend in surfaced mileage for the whole country. The rate of increase in total rural mileage for the last eleven years has slowed up considerably. From 1923 to 1925 the increase for the entire country was only one half of one per cent. Surfaced mileage, on the other hand, is gaining steadily. Every year has seen an increase of 30,000 miles or more (except 1917 and 1918 the war years). The record year was 1925, during which over 50,000 miles of roads were surfaced.



Government Road Statistics—Total Rural Road Mileage Existing in the United States at End of Year Compared With Number of Miles Surfaced

State	1904			1909			1914			1915			1916			1917		
	Total Road Mileage	Miles Surfaced	Per Cent Surfaced	Total Road Mileage	Miles Surfaced	Per Cent Surfaced	Total Road Mileage	Miles Surfaced	Per Cent Surfaced	Total Road Mileage	Miles Surfaced	Per Cent Surfaced	Total Road Mileage	Miles Surfaced	Per Cent Surfaced	Total Road Mileage	Miles Surfaced	Per Cent Surfaced
Maine	25,528	2,324	9.1	25,528	2,703	10.6	23,537	2,762	11.7	25,528	3,000	11.7	23,537	3,250	13.8	23,537	3,420	14.5
New Hampshire	15,116	1,293	8.6	15,116	1,448	9.6	14,020	1,660	11.8	14,020	1,800	12.8	14,020	1,900	13.5	14,020	1,975	14.1
Vermont	14,521	1,954	13.4	14,406	2,651	18.4	14,249	1,442	10.1	15,082	3,478	23.1	14,249	2,100	14.9	14,249	2,220	15.7
Massachusetts	17,092	7,844	45.9	17,272	8,463	49.0	18,681	8,506	45.5	18,681	8,800	46.6	18,681	8,900	47.6	18,681	9,050	47.5
Rhode Island	2,631	1,021	43.3	2,121	1,042	49.1	2,170	693	32.0	2,121	1,246	58	2,170	750	34.5	2,170	750	34.5
Connecticut	14,088	2,366	16.8	12,583	3,031	24.1	14,061	2,975	21.2	14,061	3,200	22.7	14,061	3,100	22.0	14,061	3,160	22.4
New England	88,976	16,796	18.9	87,026	19,338	22.2	86,718	18,038	20.8	89,493	21,524	24.1	86,718	20,000	23.0	86,718	20,575	23.7
New York	73,798	5,876	8.0	79,279	12,787	16.1	79,398	15,636	19.6	80,112	17,500	21.8	79,398	18,000	22.7	79,398	18,400	23.2
New Jersey	14,842	2,422	16.3	14,842	3,378	22.8	14,817	5,897	39.8	14,817	4,600	31.0	14,817	6,000	40.5	14,817	6,050	41.0
Pennsylvania	99,777	2,161	2.2	87,387	3,365	3.8	91,556	9,983	10.9	91,556	9,883	10.8	91,556	10,500	11.4	91,556	10,600	11.6
Maryland	16,773	1,570	9.4	16,773	2,142	12.8	16,459	2,489	15.1	3,674	300	8.0	16,459	3,000	18.2	16,459	3,000	18.2
Delaware	3,000	66	2.2	3,000	186	6.2	3,674	244	6.6	16,458	2,950	17.9	3,674	275	8.0	3,674	300	8.2
Middle Atlantic	208,190	12,095	5.8	201,281	21,858	10.9	205,904	34,249	16.7	206,617	35,233	17.0	205,904	37,675	18.3	205,904	38,350	18.6
Virginia	51,812	1,600	3.1	43,399	1,903	4.4	53,388	3,910	7.3	53,388	4,760	8.9	53,388	5,500	10.3	53,388	5,900	11.0
West Virginia	26,178	255	1.0	32,109	591	1.8	32,024	1,065	3.3	32,024	1,200	3.7	32,024	1,532	4.7	32,024	1,600	5.0
North Carolina	49,763	1,259	2.5	48,285	2,313	4.8	50,758	6,004	11.8	50,758	6,500	12.8	50,758	6,750	13.3	50,758	6,850	13.5
South Carolina	41,830	1,878	4.5	32,085	3,535	11.0	42,226	3,271	7.7	42,220	3,500	8.3	42,226	3,700	8.8	42,226	3,800	9.0
Georgia	57,203	1,634	2.9	82,230	5,979	7.3	80,669	12,342	15.3	84,770	13,000	15.3	80,669	13,000	15.3	80,669	13,200	16.4
Florida	17,374	886	5.1	17,579	1,752	10.0	17,995	2,830	15.7	17,995	3,500	19.4	17,995	3,300	19.4	17,995	3,800	21.1
Alabama	50,089	1,720	3.4	49,639	3,264	6.6	55,446	4,989	9.0	55,446	5,915	10.7	55,446	6,000	10.8	55,446	6,050	10.9
Mississippi	38,698	149	0.3	39,619	342	0.9	45,779	2,133	4.7	45,778	2,500	5.5	93,517	6,500	7.0	93,517	6,900	7.4
Louisiana	24,897	34	0.1	24,962	330	1.3	24,563	2,068	8.4	24,562	2,250	9.1	24,563	2,400	9.8	24,563	2,700	11.0
Kentucky	57,137	9,486	16.6	53,744	10,115	18.8	57,916	12,403	21.4	57,916	13,000	22.1	57,916	13,400	23.2	57,916	13,900	24.0
Tennessee	48,989	4,285	8.8	45,913	5,356	11.7	46,050	8,102	17.6	46,050	8,625	18.7	46,050	8,750	18.9	46,050	8,875	19.2
Southern	463,970	23,186	5.0	469,554	35,479	7.6	506,814	59,117	11.7	510,907	64,750	12.7	554,552	71,032	12.8	554,552	73,575	13.3
Ohio	69,439	23,460	33.8	88,861	24,106	27.1	86,354	30,569	35.2	86,453	30,920	35.8	86,354	31,500	36.5	86,354	31,800	36.8
Indiana	68,306	23,887	35.0	67,996	24,956	36.7	73,347	30,962	42.2	63,370	27,000	42.6	73,347	31,000	42.5	73,347	31,000	42.5
Illinois	94,141	7,924	8.4	94,141	8,914	9.5	95,647	11,606	12.0	94,141	11,000	11.7	95,647	12,400	13.0	95,647	12,750	13.3
Wisconsin	63,593	10,633	16.7	61,090	10,167	16.6	75,707	13,399	17.6	75,702	14,050	18.5	75,707	14,850	19.6	77,280	15,250	19.8
Michigan	69,296	7,026	10.1	68,906	6,901	10.0	74,190	7,829	10.6	74,089	8,600	11.6	74,190	9,600	13.0	74,190	10,600	14.3
Middle West	364,775	72,930	20.0	380,994	75,044	19.7	405,245	94,366	23.2	393,755	91,570	23.5	405,245	99,350	24.2	406,818	101,400	24.9
Minnesota	79,324	6,248	7.9	79,323	5,417	6.8	93,517	3,968	4.2	93,500	5,500	5.9	93,517	6,500	7.0	93,517	6,900	7.4
Iowa	102,448	1,664	1.6	102,427	2,505	2.5	104,074	615	0.6	106,847	1,000	1.0	104,074	1,000	1.0	104,074	1,400	1.3
Missouri	108,133	2,733	2.5	107,923	4,756	4.4	96,041	6,713	7.0	96,124	8,000	8.3	96,041	7,250	7.6	96,041	7,500	7.8
Arkansas	36,445	236	0.6	36,445	1,085	3.0	50,743	1,098	2.2	50,743	1,200	2.3	50,743	1,500	3.0	50,743	1,725	3.4
North Dakota	59,332	212	0.4	61,593	140	0.2	68,796	955	1.4	68,000	1,100	1.6	68,796	1,100	1.6	68,796	1,150	1.7
South Dakota	59,295	151	0.3	56,354	286	0.5	96,306	363	0.4	96,306	850	0.9	96,306	750	0.8	96,306	800	0.8
Nebraska	79,462	23	0.03	80,338	249	0.3	80,272	1,205	1.5	80,336	500	0.6	80,272	1,350	1.7	80,272	1,400	1.8
Kansas	101,196	273	0.3	98,302	375	0.4	111,052	1,149	1.0	111,536	1,250	1.1	111,052	1,400	1.3	111,052	1,500	1.3
Oklahoma	43,554	...	...	71,325	361	0.5	107,916	122	0.1	107,916	300	0.3	107,916	300	0.3	107,916	500	0.5
Texas	121,409	2,128	1.8	128,971	4,896	3.8	128,960	10,527	8.2	128,960	12,000	9.3	128,960	12,000	9.3	128,960	12,100	9.4
Montana	22,419	65	0.3	23,319	95	0.4	39,204	609	1.6	39,204	775	2.0	39,204	800	2.0	39,204	850	2.2
Wyoming	10,447	153	1.5	10,569	416	3.9	14,797	469	3.1	14,381	500	3.5	14,797	520	3.5	14,797	550	3.8
Colorado	30,214	178	0.6	29,693	321	1.1	39,780	1,194	3.0	39,691	1,750	4.4	39,780	1,800	4.6	39,780	2,500	6.3
New Mexico	15,326	2	0.01	16,920	104	0.6	11,873	262	2.2	11,873	450	3.8	11,873	550	4.6	11,873	600	5.0
West of Mississippi	869,004	14,066	1.6	903,502	21,006	23.3	1,043,331	29,249	2.8	1,045,417	35,175	3.4	1,043,331	36,820	3.4	1,043,331	39,475	3.8
Idaho	18,163	212	1.2	18,403	511	2.8	24,396	679	2.8	23,109	950	4.1	24,396	800	3.3	24,396	825	3.4
Utah	7,090	608	8.6	8,320	1,018	12.2	8,810	1,154	13.1	15,000	1,053	7.0	8,810	1,500	17.1	8,810	1,550	17.5
Arizona	5,987	217	3.6	5,987	273	4.6	12,075	253	2.1	12,075	350	2.9	12,075	375	3.1	12,075	425	3.5
Nevada	12,585	64	0.5	12,751	46	0.4	12,182	262	2.1	15,000	75	0.5	12,182	320	2.6	12,182	340	2.8
Washington	31,998	1,977	6.2	34,284	4,521	13.2	42,428	4,922	11.6	42,428	5,460	12.8	42,428	5,900	13.9	42,428	6,225	14.7
Oregon	34,258	2,589	7.6	29,475	2,799	9.5	36,819	4,726	12.8	36,819	7,780	21.1	36,819	4,875	13.2	36,819	4,950	13.4
California	46,653	8,803	18.9	48,069	8,588	17.9	61,039	10,280	16.8	61,038	13,000	21.3	61,039	12,300	20.2	61,039	12,800	20.9
Far West	156,734	14,470	9 2	157,289	17,756	11 3	197,749	22,276	11.2	205,469	28,668	13.9	197,749	26,070	13.2	197,749	27,115	13.7
United States	2,151,379	153,530	7.1	2,199,645	190,476	8.7	2,445,761	257,292	10.5	2,451,660	276,920	11.3	2,455,761	287,047	11.6	2,457,334	296,290	12.0

Government Road Statistics—Total Rural Road Mileage Existing in the United States at End of Year Compared With Number of Miles Surfaced

State	1918			1921			1923			1924			1925			Percent Increase of 1925 Over 1914	
	Total Road Mileage	Miles Surfaced	Per Cent Surfaced	Total Road Mileage	Miles Surfaced	Per Cent Surfaced	Total Road Mileage	Miles Surfaced	Per Cent Surfaced	Total Road Mileage	Miles Surfaced	Per Cent Surfaced	Total Road Mileage	Miles Surfaced	Per Cent Surfaced	Total Rural Highways	Surfaced Mileage
Maine	23,537	3,525	14.9	21,483	2,953	13.8	20,940	3,569	17.1	20,940	3,964	19.0	20,766	4,279	20.3	—12	55
New Hampshire	14,020	2,000	14.5	13,841	1,692	12.2	13,088	1,170	8.9	13,088	1,226	9.4	13,802	1,893	13.7	— 1.5	13
Vermont	14,249	2,300	16.3	14,677	3,545	24.2	14,861	4,345	29.2	14,861	4,481	30.2	14,874	4,680	31.5	4	224
Massachusetts	18,681	9,100	48.8	18,868	6,575	34.9	19,100	7,182	37.5	19,098	7,310	38.3	19,082	7,888	41.4	2	— 7
Rhode Island	2,170	750	34.5	2,274	754	33.2	2,320	607	26.2	2,320	651	28.0	2,374	777	32.8	9	12
Connecticut	14,061	3,200	22.6	12,152	2,206	18.2	12,178	2,345	19.3	12,219	2,441	20.0	13,346	2,610	19.6	— 5	—12
New England	86,718	20,875	24.0	83,295	17,725	21.3	82,487	19,218	23.4	82,526	20,073	24.3	84,244	22,127	26.2	— 3	22
New York	79,398	18,400	23.2	81,878	18,566	22.7	81,873	22,890	28.0	81,873	24,539	30.0	81,873	26,363	32.1	3	68
New Jersey	14,817	6,050	41.0	14,066	6,459	45.9	17,641	7,390	41.2	17,720	7,451	42.1	17,721	7,608	43.0	20	25
Pennsylvania	91,556	10,600	11.6	90,991	13,921	15.3	91,971	15,550	16.9	92,021	16,099	17.5	92,759	18,958	20.4	7	90
Maryland	16,459	3,100	18.8	14,772	3,663	24.8	14,735	4,180	27.6*	14,886	4,357	29.3	14,868	4,689	31.5	—10	88
Delaware	3,674	310	8.5	3,933	448	11.4	4,344	630	14.5	4,411	697	15.8	3,796	782	20.6	3	221
Middle Atlantic	205,904	38,460	18.7	205,640	43,057	20.0	210,561	50,510	24.0	210,911	53,143	25.1	211,017	58,401	27.6	2.5	70
Virginia	53,388	6,150	11.7	59,080	7,260	12.3	59,650	7,098	11.9	59,872	7,362	12.2	59,080	9,782	15.8	11	150
West Virginia	32,024	1,600	5.0	35,173	1,367	3.9	35,373	1,426	4.0	35,435	*1,677	4.6	35,243	1,628	4.6	10	52
North Carolina	50,758	6,850	13.5	68,204	16,755	24.6	67,807	17,213	25.4	67,907	18,150	26.8	68,148	20,017	29.4	34	233
South Carolina	42,226	3,800	9.0	61,850	6,908	11.2	63,684	8,462	13.3	64,409	9,081	13.7	64,633	10,061	15.6	53	225
Georgia	80,669	13,200	16.4	94,912	18,339	19.3	97,927	18,619	19.1	98,365	19,187	19.5	97,892	18,710	19.2	21	51
Florida	17,995	3,900	21.6	27,643	6,438	23.3	28,338	8,443	29.0	28,414	8,999	31.4	30,263	9,844	32.5	68	241
Alabama	55,446	6,125	11.0	58,410	10,420	17.8	61,460	11,884	18.4	61,591	12,510	20.3	61,541	13,561	22.0	11	172
Mississippi	45,779	2,700	5.9	53,085	5,744	10.8	56,673	8,897	15.5	56,880	9,241	16.3	56,108	9,910	17.7	22	365
Louisiana	24,563	2,700	11.0	39,803	2,771	7.0	39,803	3,950	10.0	39,803	4,678	11.7	39,803	5,184	13.0	62	151
Kentucky	57,916	13,900	24.0	68,704	15,436	22.5	67,204	15,991	23.8	68,704	17,066	24.8	68,704	17,230	25.1	19	39
Tennessee	46,050	8,880	19.2	62,546	9,878	15.8	64,655	11,977	18.5	64,727	12,333	19.0	65,322	13,325	20.4	41	64
Southern	506,814	69,865	13.8	629,410	101,316	16.1	642,584	113,960	17.7	646,017	120,284	18.6	646,737	129,252	20.0	28	118
Ohio	86,354	31,800	36.8	84,219	36,068	42.8	84,451	32,610	37.5	84,532	33,581	39.6	84,883	40,249	47.5	— 2	32
Indiana	73,347	31,000	42.5	76,246	39,857	52.3	80,436	38,087	47.5	*80,534	40,645	50.5	73,131	48,125	65.9	— .5	55
Illinois	95,647	12,800	13.4	96,326	11,473	11.9	96,326	12,964	13.5	96,328	14,173	14.7	96,327	15,259	16.0	1	31
Wisconsin	77,280	15,500	20.1	78,679	19,714	25.1	78,886	21,483	27.3	78,964	24,437	31.0	78,964	28,318	35.9	4	112
Michigan	74,190	10,600	14.3	77,283	17,186	22.2	77,283	19,218	24.9	77,283	20,997	27.2	77,283	21,514	27.9	4	175
Middle West	426,818	101,700	23.8	412,753	124,298	30.1	417,382	124,362	29.8	417,641	133,833	32.0	410,588	153,465	37.3	1.5	64
Minnesota	93,517	7,000	7.5	107,103	16,905	15.8	107,221	20,786	19.3	107,817	22,310	20.7	108,081	24,385	22.5	15	514
Iowa	104,074	1,500	1.4	104,082	2,585	2.5	104,464	4,026	3.8	104,624	4,728	4.5	102,921	5,986	5.8	— 7	875
Missouri	96,041	7,550	7.8	111,520	7,879	7.1	111,520	8,322	7.5	112,100	9,535	8.5	110,500	10,658	9.6	15	59
Arkansas	50,743	2,000	4.0	74,866	3,871	5.2	74,562	4,798	6.4	74,865	5,839	7.8	74,865	6,499	8.7	47	492
North Dakota	68,796	1,160	1.8	106,523	710	0.7	106,458	1,049	1.0	106,498	1,055	1.0	106,498	1,784	1.7	55	87
South Dakota	96,306	800	0.8	115,485	548	0.5	115,684	1,486	1.3	115,805	2,014	1.7	116,906	3,007	2.6	21	740
Nebraska	80,272	1,450	1.8	86,556	496	0.6	87,292	578	0.7	87,292	1,141	1.3	87,169	2,502	2.0	9	108
Kansas	111,052	1,550	1.4	128,551	1,100	0.9	128,674	1,242	1.0	129,125	*1,410	1.1	127,964	3,195	2.5	15	178
Oklahoma	107,916	700	0.7	134,263	2,461	1.8	134,223	1,347	1.0	134,262	1,668	1.2	134,262	1,686	1.3	25	1,280
Texas	128,960	12,300	9.6	167,685	14,883	8.9	167,687	18,046	10.8	167,685	19,049	11.3	167,685	20,115	12.0	30	91
Montana	39,204	900	2.3	64,732	1,772	2.7	67,100	800	1.2	67,177	930	1.4	67,177	1,189	1.8	71	95
Wyoming	14,797	600	4.1	46,528	440	1.0	44,532	514	1.1	46,319	724	1.6	46 576	907	1.9	214	94
Colorado	39,780	2,550	6.4	48,143	4,598	9.6	67,608	8,362	12.4	67,620	8,750	12.9	67,839	8,600	12.7	70	620
New Mexico	43,091	620	1.4	45,549	1,802	4.0	47,031	2,105	4.3	47,031	2,411	5.1	48,295	2,440	5.1	307	831
West of Mississippi	1,074,549	140,680	3.8	1,341,586	60,050	4.5	1,364,056	73,371	5.4	1,368,220	81,564	6.0	1,366,738	92,953	6.6	31	216
Idaho	24,396	850	3.5	31,099	2,982	9.6	34,816	10,493	30.1	34,816	10,968	31.4	35,402	12,116	34.2	45	79
Utah	8,810	1,650	18.6	23,047	2,544	11.0	23,381	2,831	12.0	23,381	2,954	12.6	23,381	3,132	13.4	163	170
Arizona	12,075	475	3.9	21,227	1,233	5.8	22,263	2,680	12.0	22,355	3,061	13.7	22,582	3,191	14.1	87	1,160
Nevada	12,182	340	2.8	26,057	168	0.6	22,779	605	2.7	22,779	905	4.0	23,171	1,252	5.4	90	380
Washington	42,428	6,300	14.9	45,816	12,062	26.3	48,826	16,380	33.5	48,884	16,525	33.9	49,016	17,271	35.2	16	251
Oregon	36,819	5,000	14.1	45,475	8,050	17.7	49,646	9,918	18.9	49,770	10,120	20.4	49,752	10,755	21.6	35	118
California	61,039	13,000	21.2	75,889	14,275	18.8	76,967	14,591	19.0	75,618	15,262	20.2	79,197	18,002	22.7	30	75
Far West	197,749	27,615	14.0	268,616	41,314	15.4	278,678	57,498	20.6	277,603	59,795	21.5	282,561	65,719	23.2	43	196
United States	2,478,552	299,135	12.0	2,941,294	387,760	13.2	2,995,727	439,341	14.6	*3,002,917	467,906	15.6	3,001,825	521,915	17.4	22	103

* Overestimated.

Simplified Program for Steel Spiral Reinforcement

Rod Sizes Reduced from 7 to 4 by New Recommendation of Department of Commerce Which Became Effective Dec. 15, 1926

SIMPLIFIED Practice Recommendation 53 of the United States Department of Commerce, dealing with simplified lists of sizes of steel spiral rods for concrete reinforcement, became effective as applying to new production Dec. 15, 1926. The recommendation was adopted Jan. 26, 1926, at a general conference of representatives of manufacturers, distributors and users of steel spiral rods. The recommendation, which is subject to revision when changing conditions shall necessitate the calling of a similar conference, provides that every effort should be made to clear current orders and existing stocks of eliminated sizes before March 1, 1927.

History of the Project—On Sept. 9, 1924, representatives of manufacturers, distributors and users of steel reinforcing bars met in Washington under the auspices of the Division of Simplified Practice of the Department of Commerce to consider the advisability of reducing to a minimum the number of available sizes. Simplified Practice Recommendation 26 resulted and the success of it was manifest on Jan. 26, 1926, when the first revision conference reported a satisfactory year and recommended the continuance of the schedule. Because of the success with steel reinforcing bars, it was decided to subject steel spiral rods to similar simplification. The Concrete Reinforcing Steel Institute made a survey of current practice, following which the Division of Simplified Practice called a conference of all interests.

The Conference on Steel Spirals—The first recommendation included $\frac{7}{16}$-in. spiral rods, but this size was finally eliminated. The facts, upon which this elimination was based as stated by A. E. Lindau, chairman, committee on grade of steel and standard sizes, are:

The table covers a range of core sizes from 10 to 40 in. and percentages of spiral varying from $\frac{1}{2}$ to 2 per cent and the rod sizes, $\frac{1}{4}$ in., $\frac{3}{8}$ in., $\frac{7}{16}$ in., $\frac{1}{2}$ in., and $\frac{5}{8}$ in. An examination of the table will show that for the 10- and 12-in. column cores even a rod as small as $\frac{1}{2}$ in. round will require a pitch in excess of the limitations of the joint committee for percentages up to 1 per cent. The significance of this is that rods smaller than $\frac{1}{4}$ in. round would be required, or that an excess percentage of $\frac{1}{2}$ in. round would be required. The use of spiral columns of such small diameter is so infrequent that the committee feels warranted in recommending the over-reinforcement of these columns by the use of the $\frac{1}{2}$ in. round rather than the adoption of a smaller size.

The table also will show that the $\frac{7}{16}$-in. size overlaps the $\frac{3}{8}$ and $\frac{1}{2}$ in. in all the column sizes and percentages included in the table and for that reason may well be eliminated. For similar reasons $\frac{7}{16}$- and $\frac{5}{16}$-in. sizes can be eliminated.

In view of these facts, the committee feels that the $\frac{1}{4}$-in., $\frac{3}{8}$-in., $\frac{1}{2}$-in., and $\frac{5}{8}$-in. rounds will cover all the practicable percentages in common use for column cores varying in size from 10 to 40 in.

The final decision of the conference is represented by the accompanying table (referred to in Mr. Lindau's statement), which represents a reduction from seven to four sizes of steel spiral rods, an elimination of 42.8 per cent. In the period from Dec. 15, 1926, to March 1, 1927, it is hoped that a smooth transition can be insured from the old production program to that outlined in the recommendation. Although there will be certain long-term contracts that will still have a period to run after March 1, 1927, most of the short-term orders can be cleared up and a large mass of the production directed only toward the list of simplified sizes.

PITCH OF SPIRALS FOR VARIOUS PERCENTAGES OF ROD SIZES

Percentage of Spiral	¼-In. Round			⅜-In. Round							½-In. Round							⅝-In. Round			
	½	¾	1	½	¾	1	1¼	1½	1¾	2	½	¾	1	1¼	1½	1¾	2	1	1¼	1½	2
Outside Dia. of Spirals-In.																					
10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
12	..	..	1¼	..	..	..	..	..	..	1¼	..	..	..	..	..	..	..	..	..	..	..
16	2¼	1¼	..	..	..	..	2¼	1¼	1¼	..	..	..	..	..	..	..	2¼	..	..	..	..
20	2	1¼	..	..	..	2¼	1¼	1¼	..	..	..	..	..	..	2¼	2¼	2	..	..	..	..
24	1¾	..	..	..	2¼	1¼	1¼	..	..	..	..	..	..	2¼	2¼	1¼	1¼	..	..	3	2¼
28	1¼	..	..	..	2¼	1¼	..	..	..	..	..	..	2¼	2¼	1¼	1¼	..	..	3	2¼	2¼
32	..	..	..	2¼	1¼	..	..	..	..	..	..	..	2¼	2	1¼	..	..	..	2¼	2¼	2
36	..	..	..	2¼	1¼	..	..	..	..	..	3	2¼	2	1¼	1¼	..	..	..	2¼	2	1¾
40	..	..	..	2¼	1¼	..	..	..	..	..	2¼	2	1¼	..	..	..	..	..	2	1¾	1¾

LIMITS:—Pitch not less than 1¼ in. for ¼ in. rod. Pitch not less than 1¾ in. for all others. Pitch not greater than ½ of diameter. Pitch not greater than 3-in.

When the Front-Foot Plan of Assessment Is Invalid

Washington Repaving Assessment Illegal Because Lots Vary in Depth and Value and Benefit Is Largely General

THE front-foot basis of assessments for benefits, imposed by Congress in 1916 to be applied to all repaving work not less than a block in length, has been declared invalid by the U. S. Court of Appeals, District of Columbia, in a decision reversing the Supreme Court of that district. The higher court holds that as related to the particular assessment in question, and as a rule prospectively applicable throughout the district, the front-foot method is arbitrary, not according to benefit and in some cases confiscatory. Moreover, the higher court also held that the benefit of the repaving work which gave rise to the case at bar was more than local, being on a through route to Baltimore, whereas the Congressional Act did not even recognize benefit districts but was on a block-by-block basis—street intersections and paving between street railway tracks excepted. By implication at least, an amendment to the act, passed in 1916, ruling out public hearings as a condition precedent to repaving assessments, was condemned, although invalidity was based on the major fault already indicated. At latest accounts, the district authorities had not decided whether to carry the case to the United States Supreme Court. The decision in full (William G. Johnson and others vs. Commissioners of the District of Columbia) is given in the *United States Daily* (Washington, D. C.), Dec. 15 and 16, 1926.

The decision is of country-wide interest because it includes a review of a number of leading decisions and concludes with a summary of conditions under which

the front-foot rule is and is not valid. In general, this summary rules out the front-foot basis for repaving if not for original paving of through streets.

The land in controversy fronts on Rhode Island Ave. and is largely "improved city property." This avenue is one of the well-known diagonal or radial streets of Washington, which give rise to great variations in lot depths, some of the blocks being triangular. The plaintiff contended, the opinion states, that because of the "peculiar relation of his and other property to Rhode Island Ave., the assessments made on the frontage basis were arbitrary, unequal and discriminatory." As to the front-foot basis of assessments in general, the court holds that there is no question in the case of "uniform city squares" and lots of "uniform depth and of comparatively equal value and when the assessments are not in excess of the benefits."

In the property under consideration there is a "narrow triangular piece" of land which at one point "has a depth of less than 1 ft., and a greatest depth of less than 50 ft., yet this land has a frontage of about 200 ft. on Rhode Island Ave., which is assessed at the same rate per front foot as all the other property on the avenue irrespective of depth. To permit the assessment as levied "would result in practical confiscation" of this land. An adjacent block, ranging from 261 to 386 ft. in depth, was assessed at the same front-foot rate as the triangular block. Some of the other land assessed for repaving Rhode Island Ave., the evidence showed, "has been little, if any, benefited by the improvement," since "for farm purposes and the convenience of reaching the city, [the old] macadam pavement would meet the requirements equally with [the new] asphalt pavement. Consequently the new paving "was an improvement of general public benefit rather than for the benefit of the farm property that may lie adjacent thereto."

Counsel for the District of Columbia tried to support the assessment by citing a U. S. Supreme Court decision upholding an Act of Congress authorizing the Commissioners of the District of Columbia to levy assessments for new water mains at the rate of $1.25 per front foot, without giving property owners a hearing. The court in the case just decided held that there is a marked distinction between this assessment and the one in question for repaving, in that a water main "is a local improvement" almost solely beneficial to the adjoining property, and assessment for it an act of taxation wholly within the jurisdiction of the local authorities, whereas the repaving in controversy is "an improvement not beneficial to the people of the district in general and to the country beyond."

Toward the close of its opinion, after reviewing a number of pertinent decisions of the highest state and federal courts, the present opinion reads:

Our attention has not been called to a case where a general repaving act calling for an arbitrary assessment of the expenses, or a portion thereof, against the abutting property, regardless of resulting benefits, has been upheld. It may well be that conditions could exist so equitable and fair that an assessment on the front-foot plan might be sustained, but to do so there must be a relative equality in the value and depth of the abutting property, and the assessments must not exceed the benefits.

As an example of a front-foot paving assessment held by our highest court to be equitable the current opinion summarizes the opinion in French vs. Barber Asphalt Paving Co., 181 U. S., 324, involving Forest Ave., "one of the oldest and best improved residence streets" in Kansas City, which was paved with asphalt for its width of 36 ft. Justification of this assessment was based on all the lots being of equal depth, all improved and used for residence purposes, all at substantially the grade of the street, and otherwise similarly related to the pavement, all the pavement uniform in distance and quality and no showing of difference in value of the lots. The entire proceedings in this case complied with the charter requirements as to advertising, hearings, etc. No one protested against the work. The whole course of events disclosed a "presumption of acquiescence, equality, and benefits equal to the tax, in support of the validity of an assessment on the front-foot basis."

Although accepting the front-foot plan as valid under certain conditions, like those just enumerated, the opinion in the Washington case closes with a summary of conditions which are fatal to it in general and also as regards the Washington case thus adversely decided:

Special statutes or ordinances providing for the assessment of benefits equivalent to the cost of the improvement on the frontage basis, where the statute or ordinance relating to an assessment for a local improvement, as, for example, the opening and grading of a street, converting unimproved land into city property, where not grossly unequal or inequitable, will be upheld.

The front-foot method of assessment for street improvement under a general statute is condemned especially on the theory that it taxes the individual property fronting on the improvement for all or a fixed portion of the expense, to the exemption of all other property in the municipality.

It is not a local improvement beneficial chiefly to the immediate property affected; but a public improvement, the expense of which should be borne by all the property of the community on an equal proportionate basis. To thus tax all or an unequal portion of the burden of the expense of a general public improvement against the property of a single person or a group of persons, to the exemption of the public generally, falls within the constitutional inhibition forbidding the taking of private property for a public use without just compensation.

Cooley, in his work on Taxation, 3rd Ed., 1224, condemning the frontage rule when applied to a public street improvement, said: "It considers each lot by itself, compelling each to bear the burden of the improvement in front of it, without reference to any contribution to be made to the improvement of any other property, and it is consequently without any apportionment. From accidental circumstances, the major part of the cost of an important public work may be expended in front of a single lot; those circumstances not at all contributing to make the improvement more valuable to the lot thus especially burdened, perhaps even having the opposite consequence. But whatever might be the result in particular cases, the fatal vice in the system is that it provides for no taxing districts whatever. It is as arbitrary in principle, and would sometimes be as unequal in operation, as a regulation that the town from which a state officer chanced to be chosen should pay his salary, or that the locality in which the standing army, or any portion of it, should be stationed for the time being should be charged with its support. If one is legitimate taxation the other would be."

We are forced to the conclusion that there is no theory on which the legality of this assessment can be sustained. If the paving of Rhode Island Ave. be treated as an original improvement, converting a highway into a paved city street, its constitutional infirmities are emphasized by reason of the existence of physical conditions forbidding any equal, fair or equitable application of the frontage rule of taxing benefits. If considered as a repair of the avenue, in the form of repaving, its validity must be condemned for the additional considerations pointed out, bringing it within the scope of a general city improvement.

The decree is reversed with costs, and the cause is remanded for further proceedings not inconsistent with this opinion.

Township Roads Should Be Merged with County Roads

Analysis of Township Road Upkeep Costs in Indiana Forces Conclusion that Administration by Counties Is Cheaper

By Ben H. Petty
Assistant Professor of Highway Engineering, Purdue University, Lafayette, Ind.

WHILE the township road is of minor importance to the state road and is also subordinate to the county road it is of vital interest to a large percentage of those living in rural communities. The financing, supervision and maintenance of township roads varies considerably in different states. In Indiana all unimproved roads are classed as township roads. They are principally narrow, poorly-drained earth roads, although some have received thin coatings of gravel. When one of these roads has been properly constructed and given an adequate coating of metal to meet the county standards, it passes into the care of the county highway superintendent for future maintenance.

The road mileage in Indiana is classified approximately as follows: State 4,000 miles, county, 37,500 miles and township, 40,000 miles. The disbursements for highways and streets during the fiscal year ending Sept. 30, 1926, were:

State	$14,518,044
Counties	14,417,313
Civil townships	12,187,011
Civil cities	3,776,861
Civil towns	696,498
Total	$45,595,730

The township's expenditures for roads equaled 84 per cent of the counties' total. For maintenance alone, in 1924, the townships collected $2,886,350 in taxes as compared to $6,557,145 collected by the counties. Of the township roads 79 per cent are earth roads.

The care of township roads is entrusted to the township trustee (an elective officer) who also has supervision over the township schools. The trustee and three advisors (elected at the same time) comprise the advisory board which fixes the tax levy for township road repair. The maximum allowable levy is 30c. per $100 of taxable property. There are 1,016 townships in the state which means that there are approximately 1,000 trustees looking after 31,600 miles of unimproved roads, each with his own peculiar ideas as to the proper type of equipment to buy and of maintenance procedure to be observed. In many parts of the state these roads are impassable during a great part of the fall, winter and spring seasons and are traveled with difficulty and discomfort even during the dry summer months.

During the past four summers the writer has engaged in highway extension work for the University which has taken him into almost every county of the state and during which he traveled over about 10,000 miles of various types of roads. The first-hand knowledge gained in this way has raised the question as to whether or not present methods of handling the town-

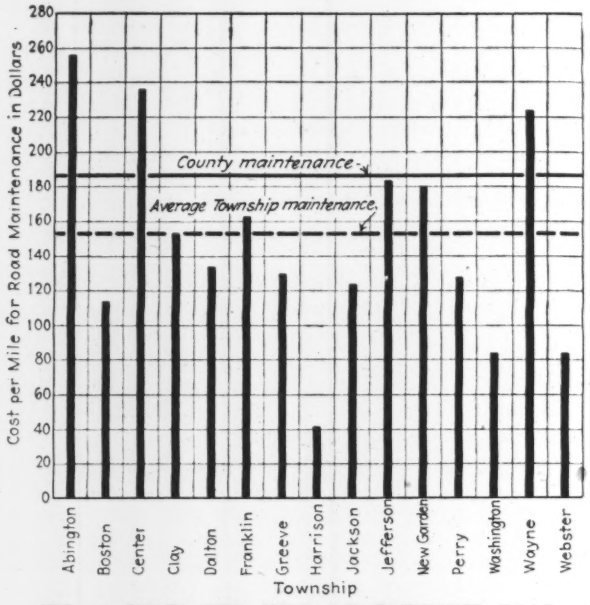


FIG. 1—COSTS PER MILE OF TOWNSHIP ROAD MAINTENANCE IN WAYNE COUNTY, INDIANA

TABLE I.—FUNDS FOR ROAD REPAIR IN WAYNE COUNTY, INDIANA, IN 1924

Townships Cities and Towns	Net Taxable Valuations	Rate for Road Repair, Township	Rate for Road Repair, County	Per Cent Township and County Combined	Township Net Revenue for Road Repair	County Net Revenue for Road Repair	Miles of Tp. Road	Miles of County Road	Cost per Mile Tp. Road
Abington	$1,328,355	.25	.10	.35	$3,320.89	$1,328.36	13	....	$255.45
Boston	2,150,714	.10	.10	.20	2,150.72	2,150.72	19	....	113.19
Center	4,914,657	.11	.10	.21	5,406.12	4,914.66	23	....	235.04
Clay	1,939,643	.11	.10	.21	2,133.61	1,939.64	14	....	152.40
Dalton	956,236	.18	.10	.28	1,721.22	956.24	13	....	132.40
Franklin	2,022,211	.08	.10	.18	1,617.77	2,022.21	10	....	161.78
Greeve	2,442,351	.10	.10	.20	2,442.35	2,442.35	19	....	128.54
Harrison	1,355,139	.04	.10	.14	542.06	1,355.14	13	....	41.69
Jackson	3,333,793	.07	.10	.17	2,333.66	3,333.79	19	....	122.82
Jefferson	3,110,734	.10	.10	.20	3,110.73	3,110.73	17	....	182.98
New Garden	1,981,204	.10	.10	.20	1,981.20	1,981.20	11	....	180.10
Perry	1,354,030	.15	.10	.25	2,031.05	1,354.03	16	....	126.94
Washington	3,236,235	.08	.10	.18	2,588.99	3,236.24	31	....	83.51
Wayne	8,254,529	.10	.10	.20	8,254.53	8,254.53	37	....	223.09
Webster	1,314,078	.07	.10	.17	919.86	1,314.08	11	....	83.62
Boston Corp.	192,940	....	.10	....	.....	192.94	..	.....	.....
Cambridge City Corp.	2,005,931	....	.10	....	.....	2,005.93	..	.....	.....
Centerville Corp.	883,181	....	.10	....	.....	883.18	..	.....	.....
Dublin Corp.	440,545	....	.10	....	.....	440.55	..	.....	.....
E. Germantown Corp.	184,727	....	.10	....	.....	184.73	..	.....	.....
Economy	186,580	....	.10	....	.....	186.58	..	.....	.....
Fountain City Corp.	319,494	....	.10	....	.....	319.49	..	.....	.....
Greensfork Corp.	338,074	....	.10	....	.....	338.07	..	.....	.....
Hagerstown Corp.	1,316,975	....	.10	....	.....	1,316.98	..	.....	.....
Milton Corp.	439,018	....	.10	....	.....	439.02	..	.....	.....
Mt. Auburn Corp.	76,583	....	.10	....	.....	76.58	..	.....	.....
Richmond Corp.	35,971,655	....	.10	....	.....	35,971.66	..	.....	.....
Spring Grove Corp.	160,366	....	.10	....	.....	160.37	..	.....	.....
Whitewater Corp.	42,550	....	.10	....	.....	42.55	..	.....	.....
Total	$82,252,528	....	....	....	$40,554.76	$82,252.55	266.0	442.0	.....
Column No. 1	2	3	4	5	6	7	8	9	10

TABLE II.—SUMMARY SHEET—FUNDS FOR ROAD REPAIR IN SEVEN COUNTIES, STATE OF INDIANA

County	Average Cost per Mile Township Roads	Cost per Mile County Roads	Total Funds Now Spent for Road Repair on County and Township Roads	County Rate Necessary to Raise Present Total Per Cent	Total Funds Required to Maintain All Roads on County Basis	County Rate Necessary to Maintain All Roads on County Basis Per Cent	Net Change in County Road Repair Funds If All Roads Were Maintained on County Basis	Per Cent Change in County Road Repair Funds If All Roads Were Maintained on County Basis
Huntington	$262.02	$168.25	$140,731.98	.2296	$121,058.41	.1976	—$19,673.57	—13.9
Wayne	152.46	186.09	122,807.31	.1493	131,752.49	.1601	+ 8,945.18	+ 7.28
Gibson	93.75	255.60	119,957.51	.2752	176,576.51	.405	+ 56,619.00	+47.2
Clay	58.23	251.71	118,925.60	.4093	176,195.27	.6064	+ 57,269.67	+48.14
Benton	98.96	139.05	84,407.45	.1719	92,745.15	.189	+ 8,337.70	+ 9.87
Tippecanoe	103.92	134.81	116,368.37	.124	125,109.50	.1295	+ 8,741.13	+ 7.5
Boone	163.61	117.73	106,268.16	.1861	96,475.52	.169	— 9,792.64	— 9.22
Column No. 1	2	3	4	5	6	7	8	9

ship road situation cannot be considerably improved by making the county the smallest road unit.

In order to secure detailed information on this question, the writer directed R. E. Mills, a graduate student, in an investigation of county and township road affairs in Indiana during the past year. He prepared the tables and figures for this article from statistics gathered from seven counties which were so distributed over the state that they may safely be considered as representing average conditions.

Table I showing funds expended for both county and township road repair in Wayne County is typical of the information secured. Columns 3 and 4 show the tax levy for township and county road maintenance respectively. For instance, a farmer living in Abington township is assessed 25c. per hundred dollars of taxable property for township road repair plus another 10c. for county road repair, making a total repair tax levy of 35c. As a rule the county roads are in far better condition than those of the township and as a result the Abington township taxpayer, for example, is paying two and one-half times as much for poor road service as he is paying for good road service.

Fig. 1 shows graphically the average cost per mile for maintaining the various township roads of Wayne County. The average cost per mile for county roads is $186 and the township average is $152. This slight difference in cost does not in any way represent the great difference in service rendered by the two systems. It will be noted that three township averages run higher and two practically equal the county average.

Fig. 2 shows the relative maintenance costs on the two types of roads in the seven counties from which information was secured. In Huntington and Boone counties we have the remarkable condition of higher expenditures per mile for township maintenance than for county maintenance. Considering the far greater amount of traffic carried by the average county roads as compared with the average township road, an explanation of this peculiar state of affairs is quite difficult.

Table II summarizes the comparative costs of county and township road maintenance in the seven counties. Column 7 shows the tax rate necessary to produce revenue sufficient to maintain both road systems on the basis of the present cost per mile of county road maintenance. Column 9 shows reductions in two counties. The large increases in Gibson and Clay counties are explained by column 2 showing that they now spend very little on township roads. There are townships in the state that spend less than $25 per mile per year in maintaining their roads.

Marion County has absorbed all of its township roads and Tipton and Wells counties have only 3½ and 12 miles left respectively. During the present year Wayne County has taken over its entire township road mileage into the county system. This absorption of township roads on a large scale in Wayne County has produced the following immediate results:

1. The old tax levy of 10c. for maintaining county roads has now been increased to 16c. to care for the additional mileage of township road taken over. This means an increase of 6c. for taxpayers in incorporated towns who, heretofore, have paid nothing towards the maintenance of township roads.

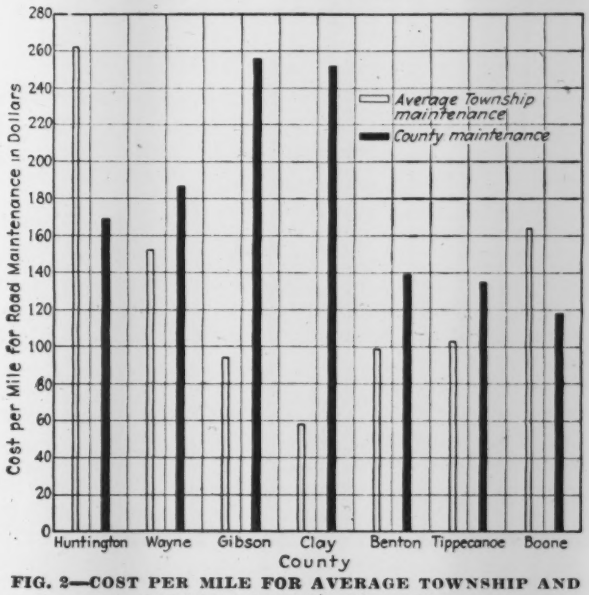


FIG. 2—COST PER MILE FOR AVERAGE TOWNSHIP AND COUNTY ROAD MAINTENANCE

2. Four of the fifteen townships will have their total road-repair tax levy reduced varying from 1 to 19c. One will face an increase of only 2c.

3. Instead of sixteen purchasing agents for road equipment and materials there will be but one.

4. The increased county road mileage will bring more gasoline tax money to Wayne County hereafter. In this state one-fourth of the gasoline tax is allotted to the counties for road repair, half of which is prorated among the 92 counties and the other half distributed on the basis of county road mileage.

5. Conflicts on gravel prices will be practically eliminated due to the reduction in number of purchasing agents.

6. Uniform maintenance methods will be enforced throughout the entire county.

7. Being a much larger taxing unit, the county is enabled to own and operate economically the larger and more expensive equipment necessary for efficient, up-to-

date road maintenance. This assures better maintenance on the absorbed township roads than the depleted township funds have been able to provide.

8. The better care of equipment and the steady employment of experienced road men afforded by the larger county organization insures a fuller return for the taxpayer's dollar.

The writer believes that in the more wealthy and progressive counties of Indiana the service rendered by the township roads would be greatly improved by merging them with the county systems. In the poorer counties where the township mileage greatly exceeds the county mileage, a gradual process of merging township roads with the county system would probably work out more satisfactorily. The taxpayers foot the bill eventually, whether township, county or state roads are involved. Therefore, any reasonable movement tending to eliminate needless friction and duplication of effort that will result in better and more economical highway service should receive whole-hearted support from the taxpayers.

Theory of Spacing Cross Joints in Concrete Roads

Moisture and Temperature Changes Analyzed, Internal and External Restraint Computed, Slab Stresses Determined

By W. W. Zass
Construction Engineer, Arkansas State Highway Commission, Little Rock, Ark.

CONCRETE expands when wetted and contracts when drying out. When it is first deposited a slight expansion takes place and then as the moisture evaporates or is used in hydration a gradual contraction occurs.

Changes Due to Moisture—In a series of experiments conducted by A. T. Goldbeck and F. H. Jackson, Jr., of the Bureau of Public Roads, columnar concrete specimens, permitting the free expansion of one specimen end thus preventing friction from affecting the accuracy of the measurements, the columns being 8 in. square and 5 ft. high composed of a 1:2:4 and a 1:3:6 mix, showed an expansion during a 15-day curing period of about 0.0001 in. per inch of length. At the end of the curing period the specimens were allowed to dry out and at the close of a 450-day interval showed a contraction from the original length of about 0.0006 in. per inch of length. At this time the specimens were again wetted and kept moist. The columns immediately began to expand and reached a maximum expansion of 0.0004 in. per inch of length at the end of a 60-day period, thus falling short of their original length by about 0.0002 in. per inch of length. Whether the original length would ever be regained or whether the shortening would prove cumulative over a series of alternate wettings and dryings is a point not now determinable but one which further investigations will possibly establish.

A specimen of 1:2:4 concrete similar in size and shape to those described above was placed out of doors subject to weather and atmospheric changes and during a 440-day period showed a maximum expansion or contraction of only 0.0001 in. per inch of length. The authors explain the difference in unit changes in length between the laboratory specimens and the specimen exposed to the weather as reasonable to expect as the latter specimen was subjected to alternate wetting and drying with sufficient frequency that there was little chance for moisture changes to become effective, experiments having proven that the larger changes in length are slow and progressive.

It is reasonable to assume that a road slab actually in place would tend to show an expansion or contraction resulting from moisture changes but little, if any, different from the test column which was freely exposed to the elements. The road slab, having one surface in contact with the subgrade, would have an opportunity to absorb and hold moisture to a greater degree than did the test column, this assumption being dependent of course upon the characteristics of the material of which the subgrade was composed. This condition would tend to keep the slab to its normal length rather than greatly contracted, due to a lack of moisture content, and would nullify to a certain extent the contraction due to a loss of moisture content resulting from the top surface of the slab being exposed to drying out agencies.

This assumption is seemingly confirmed by further investigations conducted by the same persons on several experimental sections constructed on the Chevy Chase, Md., road and on the Ohio Post Road near Zanesville. These investigations were quite exhaustive in character and in the case of the Chevy Chase Road and two sections of the Ohio Post Road showed that practically no changes in length occurred that could be attributed to variations in moisture content. In the case of the third section of the Ohio Post Road it was found that a change in length of a little over 0.0001 in. per inch of length could be attributed to variations in moisture content. This particular section lay at the foot of two 6 per cent ascending grades and the conditions were favorable for a wet subgrade and in addition this section of pavement was continually covered with mud tracked in from intersecting roads.

Assuming therefore as a basis for a safe design that the road slab is subjected to a maximum expansion or contraction due to moisture changes of 0.0001 in. per inch of length the maximum change in length of the slab per linear foot would amount to

$$0.0001 \times 1.0 \text{ ft.} \times 12.0 \text{ in.} = 0.0012 \text{ in.}$$

Changes Due to Temperature—In addition to the changes in length produced by moisture variations the slab is subjected to similar changes due to temperature variations. Recent investigations have shown that the thermal coefficient for concrete, which approximates that of steel, varies somewhat due to the richness of the mix and the degree of temperature to which it is subjected. Researches conducted by W. K. Hatt, Head of the School of Civil Engineering, Purdue University, indicate that the coefficient varies in amount depending on these factors, ranging from 0.0000040 at 40 deg. F. to 0.0000065 at 150 deg. F. It is believed that it is practicable to use a coefficient of 0.0000050 per degree of temperature change in connection with concrete paving design.

The true temperature range involved is the difference between the internal temperature of the concrete at the time of setting and the highest or lowest internal temperature it may thereafter attain due to atmospheric changes. It is evident therefore that the time or period of year during which the concrete is poured has some

effect upon any subsequent changes in length. Upon this assumption a concrete poured during the hotter months and reaching an internal temperature at the time of setting of 120 deg. F. would allow a greater contraction due to a subsequent fall of temperature than would a concrete poured during the cooler months and only reaching an internal temperature of 70 deg. F. at the time of setting. On the other hand, except in extremely hot climates, it is doubtful if the example first cited would ever show any expansion over its original length while in the second example an expansion over the original length could readily be anticipated for a range in temperature of 40 deg. to 50 deg. F. Therefore in designing the slab for atmospheric variations in the case first cited provision need be made only for a shortening or contraction from the original length while in the second case provision must necessarily be made for both contraction and expansion from the original length.

Under field conditions it would be somewhat impractical to ascertain the internal temperature of the slab at the time of setting or at any time thereafter. However, under ordinary conditions it is believed that the atmospheric temperature at the time of pouring plus 10 per cent will approximate the internal temperature of the concrete at the time of setting as at the shallow penetrations in road slabs the heat generated by the chemical action of setting is lost to a great extent by radiation. This assumption is generally confirmed by he results of investigations made by C. S. Nichols and C. B. McCullogh in the Determination of Internal Temperature Range in Concrete Arch Bridges as set forth in Bulletin 30 of the Engineering Experiment Station of Iowa State College, wherein the internal temperature of concrete at the time of setting at shallow penetrations was in excess of the atmospheric temperature at the time of pouring by approximately that amount. The internal temperature of concrete in thin slabs at any time after hydration as has been proved by many experiments, varies but little, if any, from the atmospheric temperature. Therefore for the practical purposes of design it is believed that the temperature range may be assumed as the difference between the atmospheric temperature at the time of pouring plus 10 per cent and the highest and lowest atmospheric temperature the slab is thereafter subjected to.

In accordance with the specifications under which concrete is usually placed, an atmospheric temperature of 35 deg. F. would probably be the minimum at which pouring would take place or assuming the conditions as previously outlined the minimum internal temperature at the time of setting would approximate 40 deg. F. Considering a minimum atmospheric temperature of 0 deg. F. and a maximum of 120 deg. F. a concrete with an internal temperature of 40 deg. F. at the time of setting would experience an expansional change over its original length due to a temperature rise of 80 deg. F. and would likewise experience a contractional change from its original length due to a temperature drop of 40 deg. F. On the other hand a concrete placed in midseason and reaching an internal temperature of 120 deg. F. at the time of setting would experience no expansional changes over its original length but would experience a contractional change resulting from a temperature drop of 120 deg. F.

At the coefficient named for the temperature ranges indicated the maximum expansion of the slab to be expected per linear foot would amount to

$$0.000005 \times 80 \text{ deg.} \times 1 \text{ ft.} \times 12 \text{ in.} = 0.0048 \text{ in.}$$

and the maximum contraction to be expected per linear foot would amount to

$$0.000005 \times 120 \text{ deg.} \times 1 \text{ ft.} \times 12 \text{ in.} = 0.0072 \text{ in.}$$

From a study of the above it is evident that the maximum movement of the slab in most localities is a shortening or contractional movement and such being the case the slab must be so designed that a sufficient number of contraction joints are placed in order that the tensile stress of the concrete is not exceeded. Similarly the maximum lengthening or expansional movement of the slab must be provided for in order that direct compression in the concrete may be avoided.

Combined Moisture and Temperature Changes—It is reasonable to assume that the slab may be subjected to the maximum variation due to both moisture and temperature changes at the same time; therefore combining the results obtained under the conditions outlined for changes in length due to both moisture and thermal causes we can design for the maximum variation to which the slab is subjected. These maximum variations can be listed as follows:

	Changes in length per linear foot	
	Expansion, In.	Contraction, In.
Moisture changes	0.0012	0.0012
Temperature changes	0.0048	0.0072
Total changes per foot of length	0.0060	0.0084
Total changes per inch of length	0.0005	0.0007

Stress Computations—If the slab is rigidly restrained, that is wholly constructed without joints or free ends, preventing these changes in length from taking place, a stress is created in the slab equal in amount to that required to cause the deformation. When this stress exceeds the ultimate compressive stress of the concrete the slab bulges or crushes and when the ultimate tensile stress is exceeded the slab pulls apart or cracks. It is difficult to compute accurately the stresses developed when the slab is held in restraint, as one of the factors involved, the modulus of elasticity of concrete, has a wide range in value, the value increasing with the strength of the concrete and decreasing as the unit load is increased. Professor Hatt states that the conventional value of n used for computations of deformations is 8 to 10. If the value of the modulus of elasticity of steel is assumed at 30,000,000 a value of E_c is thus obtained ranging from 3,750,000 to 3,000,000. The experiments of Stanton Walker indicate that the modulus of elasticity of a 3,000-lb. concrete will approximate a value of 5,000,000. Using the latter value will provide for higher unit stresses from the resulting computations and will therefore be considered as the value to be used in this design.

Using the expression that the modulus of elasticity of a material is the ratio of the unit stress to the corresponding unit deformation, provided the elastic limit of the material is not exceeded, and taking the values as previously expressed we find that the compressive stress induced in the slab due to restraint is

$$\frac{\text{Unit Stress}}{5{,}000{,}000} = 0.0005$$

Unit Stress = 2,500 lb. per sq.in. in compression

and the tensile stress induced in the slab is

$$\frac{\text{Unit Stress}}{5{,}000{,}000} = 0.0007$$

Unit Stress = 3,500 lb. per sq.in. in tension.

It is difficult to correlate the results of these computations with what we consider practical results in the field. It should be remembered, however, that the computations are based on the slab being rigidly restrained from longitudinal movement and it is doubtful if this condition is ever entirely met with in the field. Moreover it should be remembered that the stresses cited are maximum stresses and when caused by contraction are relieved as quickly as cracks are formed, the formation of the crack removing the condition of restraint. Construction joints furnish the same alternative in relieving the tensile stresses incurred. In the instance of expansive movements an excessive compressive stress is often relieved by a slight buckling of the slab throughout its length. It should be emphasized that the excessive stresses indicated are eliminated if the slab is divided into sections in order to provide free ends allowing movement due to changes in length.

However, some degree of exterior restraint to the movements caused by expansion and contraction will be developed in the slab owing to friction occurring between the slab and the subgrade even when free ends are provided at regular intervals. The amount of the friction developed depends on the soil characteristics of the subgrade and the care with which it is finished. This is particularly true during the curing period. After the road has been opened to traffic, vibration, induced by passing vehicles, might tend to somewhat lessen the coefficient involved. Experiments conducted by the Bureau of Public Roads indicate that the value of the coefficient of friction will probably lie between 0.50 and 2.0, the latter figure applying to the rougher subgrades. The experimental sections of the Chevy Chase and Ohio Post Roads indicate, however, that the amount of friction actually developed in practice on those particular sections was small and lay at the lower limits of the value specified. For the purposes of design under normal conditions a coefficient of 2.0 should generally prove a safe assumption and means that a force of 2 lb. must be applied to move a 1-lb. load.

The slab will be subjected to a load equivalent to the force exerted to overcome the friction developed between the mid-point of the slab and the free end on either side, the load being equal in amount to the weight of that section multiplied by the coefficient used. The maximum stress developed per square inch would amount to the force developed divided by the cross-sectional area of the slab. In the instance of a slab 1 ft. long and 1 ft. wide and 6 in. thick, estimating the weight of concrete at 150 lb. per cubic foot, and assuming the coefficient of friction at 2.0, the maximum stress developed per square inch would amount to

$$0.5 \text{ ft.} \times 75 \text{ lb.} \times 2.0 \div 6 \text{ in.} \times 12 \text{ in.} = 1.04 \text{ lb.}$$

This stress might be either tensile or compressive, depending on whether the movement was a contraction or an expansion, and increases in amount in direct proportion to the length of the slab. The compressive stress thus developed is not a determining factor in the design but the tensile stress so developed becomes the criterion on which the design is based.

The tensile strength the concrete develops is usually neglected in structural design. In the instance of a paving slab it becomes desirable and necessary that the direct tensile strength developed in the concrete be considered in the spacing of transverse joints. Experiments conducted by the Bureau of Public Roads indicate that the strength of concrete in tension may be roughly assumed as about 8 per cent of its value in compression. Assuming that the concrete has a compressive strength of 2,000 lb. per sq.in. at the end of a 15-day curing period, the time at which contraction or shrinkage usually first takes place, the maximum tension that might be developed in the concrete at that time would amount to 8 per cent of 2,000 lb. or 160 lb. per sq.in. Without using any factor of safety and based on the assumptions previously outlined, a slab length of

$$\frac{L}{2} \times 75 \text{ lb.} \times 2.0 \div 6 \text{ in.} \times 12 \text{ in.} = 160$$

$$L = 154 \text{ ft.}$$

So 154 ft. could be placed without transverse cracking occurring due to exterior restraint to the slab movement caused by friction developed between the slab and the subgrade. Using a factor of safety of 4 to allow for inferior strength concrete, for additional tensile stresses induced by live-loading and warping and for other causes a slab length of only

$$\frac{L}{2} \times 75 \text{ lb.} \times 2.0 \div 6 \text{ in.} \times 12 \text{ in.} = \frac{160}{4}$$

$$L = 38 \text{ ft.}$$

And 38 ft. could be placed without such cracking.

The maximum compressive and tensile stresses described may not develop in the period immediately subsequent to the placing of the concrete. On the contrary, a 4- to 6-month period or longer may elapse, dependent on the time the concrete is poured before the greatest movement of the slab takes place, owing to temperature or moisture conditions or both.

In résumé it may be stated that in accordance with the various assumptions outlined in the foregoing discussion it is found that the tensile and compressive stresses developed in the pavement slab are excessive when the slab is constructed wholly without transverse joints and that these stresses can be relieved by the proper placing of such joints. That the concrete can be relieved of the larger percentage of such compressive stresses occurring by placing transverse joints of the proper width at convenient intervals in order to allow any required expansion to take place and that in order that the tensile stress of the concrete is not exceeded that transverse joints be placed at intervals of 38 ft. to 154 ft. depending on the factor of safety it is desired to assume against cracks and breakage occurring. At 38-ft. intervals no transverse cracking is apt to occur in the slab due to tensile stresses developed owing to the movement of the slab from temperature and moisture changes although some transverse cracking may occur at various intervals due to direct bending from live-loads caused by warping and lack of subgrade support. When placing contraction joints it is not necessarily imperative that a wide joint be constructed but only that the continuity of the slab be broken by means of a thin filler consisting of a light-gage metal strip, tar-paper or some similar foreign material. Should it prove desirable to provide width for the assumed expansion of the slab at the same intervals as required for the contraction joint in order to allow a more pleasing appearance of regularity and uniformity the usual method of using a bituminous filler, either premolded or poured, could be followed, excepting that it is not believed practicable to place a joint less than ½ in. in width due to the possibility of foreign substances entering the joint and reducing its effectiveness.

Usable Tips on Road Maintenance

Methods and Equipment Developed by Engineers and Supervisors

Home-Made Gasoline Shovel Used in Idaho to Handle Small Yardages

By C. J. Chaffins
District Maintenance Supervisor, Idaho Bureau of Highways, Coeur d'Alene, Idaho

THE machine shown in the accompanying photograph (for convenience called "The Hoosis") which is a home-constructed gasoline shovel, was built to satisfy a long-needed requirement for a piece of equipment of this description on state highways in the northern part

THE "HOOSIS" IN USE ON AN IDAHO ROAD SLIDE

of Idaho. The shovel equipment is mounted on the rear end of a 5-ton Pierce-Arrow truck, and was constructed as follows:

An A-frame was built on the back end of the frame of the truck, and provided with a vertical swinging mast to which was attached a movable boom mounted with a fixed dipper stick and a ¾-yd. shovel. In operation the boom is swung to right or left, raised or lowered, and the bucket moved by means of cables through sheaves from a three-drum hoist mounted on the frame of the truck. The power to operate the hoist is supplied from a power take-off from the gear case of the truck. This power is transferred from the take-off to the hoist by the drive shaft and differential of a discarded truck, leaving the universal joint on the shaft to take up any warping of the frame of the truck while it is working. The universal joint eliminates the possibility of stripping any of the gears in the transmission.

This equipment is used, in connection with a fleet of two or three 3-ton trucks equipped with dump boxes, for removing slides, ditching, making fills and loading maintenance rock.

The state highway system in northern Idaho traverses a very rough country; in some places cutting through heavy rock work, with the accompanying heavy loose rock slides; and in other places passing through many long deep sand cuts. This condition made necessary removal of a large yardage of materials every year from the roadway. When this work had to be done by hand or team it was so expensive that something had to be done to relieve the situation. The cost of handling the materials with this machine is found to be about one-quarter of what it had cost by hand or team. While now we have a ¾-yd. gas shovel to handle the heavy slides it does not do away with the necessity for this piece of equipment, as it is more mobile for small jobs. The "Hoosis" can move as fast as the fleet of trucks: being sometimes moved as far as 60 miles to work on the project the same day.

While the crawler shovel is used for the heavy work the "Hoosis" is shifted all over the district doing the small jobs. We often rent the equipment to contractors for moving small amounts of binder material or to complete fills. While the equipment is not made for heavy work and cannot be considered a shovel it will put into trucks each eight hours from 90 to 125 cu.yd. of loose materials. Considering the difference between what manual handling would cost and what it costs to do the work with this machine, the machine pays for itself every year.

Kansas Treats Earth Roads with Sand To Assure All-Weather Use

By W. T. Hole
Engineering of Maintenance, Kansas State Highway Commission, Topeka, Kans.

WHILE sanding and graveling of earth roads to provide all-weather use are generally practiced, the Kansas State Highway Commission has been trying to determine the minimum amount of ordinary clean sand or fine gravel required to produce an all-weather road for moderately light traffic. This work has been carried on primarily as a maintenance improvement.

The older practice in using sand as a surfacing material has been to place 6 to 8 in. of sand, or sand-clay materials, on a heavy soil road and then by mechanical manipulation to mix this with the subgrade material as a binder to produce a compact road surface. Our experience has been that this mechanical mixing does not produce a uniform density in the surface and that under moderate traffic of from 300 to 500 vehicles daily the surface "chucks out" badly both during wet and dry weather. The sandy places fail in dry weather and the places with excess binder fail in wet weather.

Our present practice is to place not more than 2 or 3 in. of a medium to coarse grade of sand for a width of 18 ft., or a total of from 600 to 880 cu.yd. per mile on a well-graded, flat-section and thoroughly-compacted earth road. This is placed by dumping on one or both shoulders, from which place it is distributed across the roadway, as required, by the maintenance patrolmen. This material, being mixed by maintenance and traffic to a depth of from 2½ to 4 in., produces a uniformly dense

surface that withstands moderate traffic during all seasons. Results thus far have been very favorable.

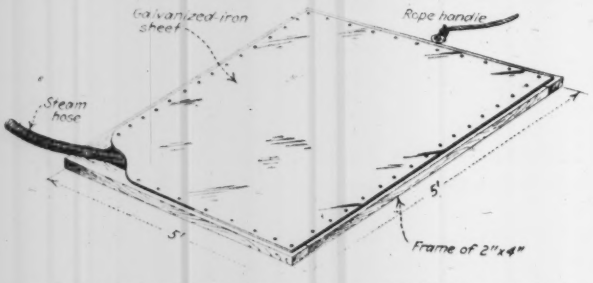
We are carrying this still further by trying applications as thin as 1 in. on the lighter soils that do not get so much traffic. We are also taking sieve analyses of the sand to determine just how fine sand may be and still give satisfactory results. The experiments with thin applications can in no way be considered as a loss, for, if required, an additional application may be placed without much expense. In fact, later applications can be placed more cheaply, due to the improved conditions of haulage.

The thinner applications of sand on the heavier soil roads produce what may be called an all-weather road. These have the advantage of being serviceable and maintainable during rainy weather when plain earth roads become impassable and impossible of maintenance.

Tar-Felt and Sand Pavement Removed by Live Steam

By L. T. Sogard
Inspector, Illinois Central R.R. Bridge Department, Chicago, Ill.

IN the repaving of the Winnebago St. viaduct over the tracks and yards of the Illinois Central, Chicago, Milwaukee, and St. Paul, and Chicago, Burlington & Quincy at Rockford, Ill., the specifications required the complete removal of the old creosoted blocks and the



DEVICE ENTRAPS LIVE STEAM FOR PITCH REMOVAL

pavement-base down to the wood decking. The original pavement consisted of three layers of tar-felt paper laid on this wood deck, each layer having been thoroughly mopped with hot pitch. A crowned sand cushion had been placed on the paper and on this cushion a pavement of 4x4x8-in. creosoted wood blocks. Hot pitch had been applied to the pavement also, as a filler.

The removal of the blocks gave the contractor no trouble; but upon baring the sand cushion, it was found that much of the pitch from between the blocks had become incorporated with the sand cushion and had formed a hard mastic. This mastic, in turn, had been impregnated in the tar-felt by traffic during 14 years of use. This mass was stone-like in hardness and might have been left in place except for the fact that it was not uniform in thickness, probably because of the shifting of the sand cushion under traffic and the vibration of the steel structure.

A light road grader was tried on the roadway but it failed to loosen anything but a little of the sand. Steam then was suggested. A small portable boiler was obtained and live steam applied to the roadway by means of a hose in which a piece of 1-in. pipe was fitted for a nozzle. The results were poor, as the area in contact with the 1-in. jet of steam was too small to permit any reasonable rate of progress. It was finally decided to trap the steam over a limited area at one time in order to receive as much of the available heat of condensation as possible and to hold the heat obtained. Accordingly a trap 5 ft. square was constructed of a frame of 2x4's and on top of this frame a sheet of galvanized iron was nailed. A small corner was left open through which to insert the steam hose, and a rope was attached for dragging the trap over the roadway.

It was found that by steaming an area for two or three minutes the mastic mass could easily be removed with a long handled scraper. It was also found that by keeping the scraper blade warmed in the ash pan of the adjacent boiler scraping was facilitated.

The entire area of the roadway, 916 ft. x 24 ft. was cleaned satisfactorily by this process in nine days. The crew consisted of a boiler fireman, one man to handle the steam hose, and two men to scrape the heated area.

This steaming method was devised by R. J. Lancaster, superintendent for the paving contractor, the Shidler Construction Materials Co., Kankakee, Illinois.

Usable Tips on

Methods and Equipment Developed

Maintenance Practice in Rhode Island

By George H. Henderson
Chief Engineer, State Board of Public Roads, Providence, R. I.

ALL our pavements with very few exceptions are hard surfaces and our maintenance is intensive and includes the patching of the metaled surface of the bituminous roads, patching and oiling the waterbound roads all of which are surface treated, refilling the joints and cracks on concrete pavements, patching, planing and oiling our few gravel roads, reshaping and oiling shoulders, gutter and ditch work and repairing guardrail and drainage structures. In addition our maintenance department takes care of snow removal, highway embellishments, detours during construction, and betterment work.

Our state is divided into five sections for maintenance purposes and a superintendent of maintenance is in charge of each section. We employ the "gang" system throughout. Each gang is in charge of a foreman who works directly under the superintendent of the section. During the winter a nucleus of the maintenance forces, including the foreman, truck drivers and two men for each truck, are kept for snow-removal work.

Holes developing in pavements during the winter months are kept filled with soft patch until a more permanent patch can be made in the spring. In the spring our first task is to patch and prepare our waterbound and gravel roads for the annual oiling, because Rhode Island being a heavily traveled state we plan to have all the surface treating work completed previous to June 15. As this work lessens, maintenance on the pavements of the hard-surfaced roads commences, which is followed by shoulder maintenance, structure repairs and ditch work. Brush cutting is carried on at the proper season of the year, while in the late fall we concentrate on opening up ditches and clearing all drainage structures to take care of winter snows and rains.

Road Maintenance

By Engineers and Supervisors

Minnesota Fights "Frost Boils" with Live Steam

By W. F. Rosenwald
Maintenance Engineer, Minnesota Highway Department, St. Paul, Minn.

In common with many other states where heavy freezing occurs during the winter, Minnesota has the problem of "frost boils" to contend with during the spring season when the frost is leaving the subgrade on the

OPENING UP A FROST BOIL WITH STEAM JET

highways. The term "frost boil" has been applied to the spongy spots (in some cases they are apparently bottomless) and to mud holes that appear intermittently due to a combination of soil conditions and a recession of the frost table, bringing about instability of the subgrade. It appears that frost boils are more apt to occur during the spring when there are hot days and few rains; and extensive tile drainage does not eliminate the trouble. It is quite likely that this can be accounted for by the fact that the lack of rain makes the recession of the frost table slow. As a consequence the frost boils have plenty of time to grow and develop to a troublesome stage before the frost table permits any special drainage structures to act.

Examination of a frost boil shows that it consists of a compacted road surface crust (which in Minnesota is usually gravel), a layer of clay subgrade saturated with water, below which is frozen ground and usually free water. In receding the frost leaves above it free water and the soil in a slightly unstable condition, and the traffic traveling over the compacted surface causes a compressing and surging action in the subgrade. If this soil is of the proper texture to absorb all the free water, portions of the subgrade are soon transformed to mud. This destroys the stability of the subgrade, the top crust breaks up and allows the mud and water to ooze up, finally creating an impassible mud hole.

We found that, in order to relieve the situation, the frost table had to be penetrated to permit the free water to escape. Early this spring one of the district maintenance superintendents, F. O. Nelson of Montevideo, decided to experiment with a small steam boiler and a steam jet, with the object of thawing holes through the frozen ground to permit the water to drain away. The accompanying picture shows the equipment and its operation. A steam jet of ordinary ½-in. pipe was easily and quickly thrust through the soil and frost. After the pipe had been thrust down it had to be left in the ground for a short time (about a minute or so) in order to permit the steam to penetrate the surrounding frozen soil and thaw out a fair-sized area.

In each case a few hours after a frost boil was steamed, an improvement was noticeable in the road surface, and in a few days the road was in good condition again. This obviated breakage of the surface crust and formation of mud.

It is quite likely that before another spring season the highway department will equip each of its sixteen districts with a steam-jetting device for the purpose of fighting frost boils.

Blower Road Cleaner Is Maintenance Equipment in Virginia

By J. J. Forrer
Maintenance Engineer, Virginia Highway Commission, Richmond, Va.

In CLEANING crushed stone or gravel roads for a bituminous surface treatment it has always been a big problem to remove the small dust particles so that

BLOWER OPERATED BY TRAILER-MOUNTED MOTOR

bitumen could penetrate and adhere to the solid surface. To accomplish this the Virginia State Highway Department developed the blower shown herewith. The blower (the same type as that which is used in sawmills to dispose of sawdust) and gas engine are mounted on a trailer. The opening in the blower is about 11 in. in diameter. From the end of the blower an elbow pipe and widened nozzle reach to within about 6 in. of the ground. The blower is operated at about 1,500 revolutions per minute and creates a current that will remove the smaller particles, leaving the larger well exposed.

ROTARY BROOM AND BLOWER CLEAN ROAD OF DUST

A combination cleaning outfit of a rotary broom attachment on the front of a small tractor with the blower in the rear works very well.

The expense of cleaning the road in the above manner may not be lowered but the results obtained more than justify the cost.

Embossed Metal Signs Manufactured by North Carolina Equipment Division

By L. R. Ames

State Highway Engineer, North Carolina Highway Commission, Raleigh, N. C.

THE North Carolina State Highway Commission is rapidly replacing its wooden signs and markers with embossed metal signs which meet the specifications of the American Association of State Highway Officials. These signs are being manufactured at the commission's "Truck Patch."

The most important procedure in this sign manufacture is in the making of dies. A male and female die is used and the metal blocks are 24 in. x 24 in. x 5 in. thick with slots for insertions. The insertions are made of special die metal 1¼ in. thick by 6 in. wide. All lettering is made on these insertions, thereby eliminating the necessity of making a die for each style of sign, which materially reduces the cost. Care is used in the making of these dies to give them the proper clearance in order that they will not receive too much strain in any one place when pressed. After the dies are made and tested, they are put in a press ready to press the metal letters.

The metal used for these signs is 18-gage, specially made for sign uses. It is received in sheets 78 in. x 26 in., is then cut into sheets 26 in. square and placed under a pressure of 200 tons. After this operation sheets are trimmed to the proper size—24 in. square for the large signs.

After being pressed and trimmed the metal is sandblasted and cleaned of rust, grease and other foreign matter. It is important that the signs be clean and free from all loose substances as any scale or grease will cause the paint to peel and allow the metal to rust. Care is taken not to allow the naked hands to touch the metal after it has been sandblasted.

The metal is now ready for painting. The method used in our sign work is different from that ordinarily employed. We use lacquer paints, which are quick-drying, elastic, and will not crack or break. The signs are first spray-painted with a metal primer. Paint is applied first around the edges, then on the surface in one direction, the process being then reversed for a double coat. One hour is allowed for drying. This priming coat is mixed as follows: three parts of highway yellow, two parts of clear primer and five parts thinner. The second, or finishing coat, is mixed with highway yellow and thinner in equal parts. The same method of application is used in this case as in the spraying of the metal primer coat. One hour is allowed for drying.

After the signs are dry they are lettered by the rolling process. Signs are placed on a magnetic plate and the current is automatically turned on. This pulls the sign down so that it is straight and smooth with the raised letters. This is done to assure a straight and uniform letter and border, because all pressed metal is somewhat warped. This operation requires about ten seconds.

I wish to call especial attention to the operation of putting black on the letters, as manufacturers of lacquer paints have advised that it is impossible to place this material on the signs by roller. However, we are doing this successfully, and find that it is all right in every respect and that the black adheres to color paint the same as in the spraying coats. The machine used for this operation has three rollers, consisting of one metal roller operating against a composition roller. The third roller, which is also a composition roller, is against roller number two which rolls the material on the sign. This roller can be adjusted to put any desired depth on letters and borders. The paint is allowed to flow on the rollers between the metal roller and the first composition roller and runs continuously while this machine is in operation. A pan is placed under these rollers to catch all excess paint, which is afterward mixed with a thinner and used again. The amount of paint, or the thickness required, is determined by the mixture that is run on the rollers. Care is taken not to use this paint too thick, for in such a case the edges of the letters and borders will be fluted. When the black lettering is finished the signs are allowed to dry, after which they are ready for shipment.

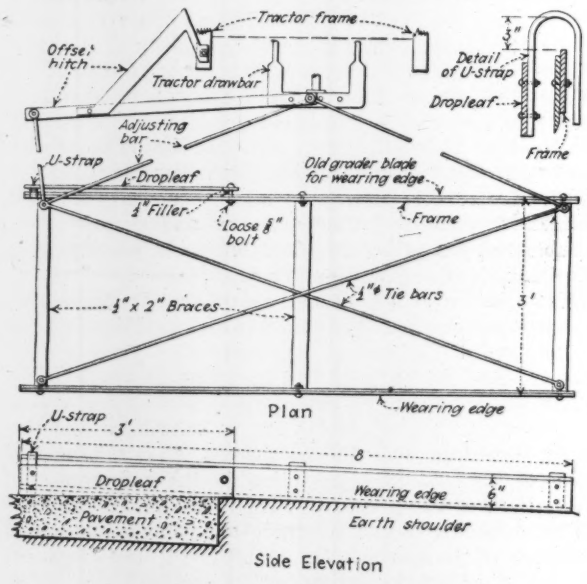
The "Truck Patch" is in charge of Charles D. Farmer, superintendent of equipment, and credit is due him and his organization for working out the details of the various operations.

Usable Tips on

Methods and Equipment Developed

Drop-Leaf Shoulder Drag Developed in California

THE necessity for a return trip when grading shoulders to throw excess material back and to clean the pavement has been obviated by a new drop-leaf shoulder drag developed by Division II of the California State Highway Commission. The drag, shown herewith, is used behind a one-man grader and is set to throw the material away from the road. It takes the excess material and smooths it over the shoulders.



SHOULDER DRAG WITH DROP LEAF

Besides making the extra trip unnecessary, the drag

Road Maintenance

By Engineers and Supervisors

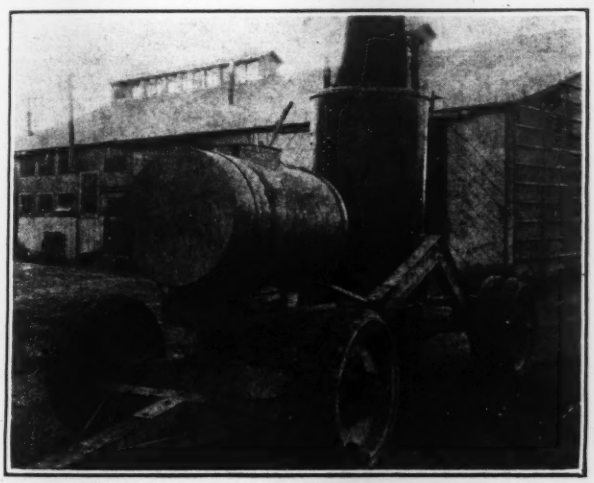
saves about one-third of the expense of grading the shoulders. The outfit was devised by F. L. Stump, maintenance superintendent, and was constructed from old grader blades and scrap iron. Total cost was about $12.

Electric Cableway Specifications—Correction

In the article "Electrical Cableway Specifications for Construction Work," by Roger F. Emerson, *Engineering News-Record*, Dec. 23, 1926, p. 1047, in the lines following the formula for finding the power required to propel the loaded bucket, *R* is the R.P.M. of motor should read *R* is the feet per minute of the cableway. And in the first part of the article the statement should have been that electrically operated cableways on construction work usually (usually was omitted) use alternating-current motors.

Notes on Maintenance

It Is Not Always Convenient to Unload tank cars, containing heavy materials, where they can be heated. To eliminate this disadvantage, the Virginia State Highway



Department developed an upright boiler mounted on a specially-designed trailer built from discarded truck parts. This equipment, shown herewith may be rather crude, but it has possibilities. The use of steam in applying water paints to road structures is possible as well as the application of bituminous emulsions. Steam is also used to great advantage in cleaning structures and equipment.

Smoothness of the Surface of Gravel Roads is maintained by the Louisiana Highway Commission by proper blading methods. During wet weather the gravel is cut out from the center to the edges and windrowed along the shoulders of the highway. The cutting out process eliminates the corrugations and pot holes. The material is worked back into the road with the graders dragging it from the sides to the center. Cutting edges are used in the first process, while flat drag blades § in. x 8 in. x 10 ft., made from high carbon-steel plates are utilized for the other. A flat crown is maintained on the roadway for easier driving and to induce traffic to use equally the entire width. The incessant pounding of the traffic crushes and pulverizes the gravel pebbles to sand. Corrugations appear and holes are formed as this condition increases. Clay binder is added to neutralize the effect, and this often accounts for the small rows of earth seen along the edges of the highways. This material is usually obtained with graders from the roadside ditches and is spread likewise, as required. Pit-run gravel is shipped in and applied when good clay binder is not available locally. It is the binder in the gravel which sets up under traffic, and consolidates the mass into a firm resistant surfacing. During dry weather it is very difficult to prevent corrugations or the formation of loose gravel, because the binder is changed to dust and loses its cementing qualities.

Highway Officials in 36 "Snow States" report a program of open roads for the snow season of 1926-27 aggregating 92,756 miles. In the winter of 1925-26 the road mileage cleared of snow in these states was about the same, compared with 62,165 miles in the winter of 1924-25. Their expenses for snow removal work last winter were in the neighborhood of $4,000,000. The 36 snow states in 1925 had 375,774 miles of surfaced rural roads, and 16,139,859 registered motor vehicles. From 1921 to 1925, inclusive, they expended about three and one-quarter billion dollars on highway improvement and maintenance.

The Department of Commerce is studying snow removal expense in various states to ascertain the best and cheapest methods. Straight blade and V-shaped plows mounted on speed trucks are extensively used. New Jersey, with an average annual snowfall of 31.8 in. and about 1,270 miles of road to be kept open, uses the straight-blade, truck-mounted plow almost exclusively. For opening drifts or packed sections of roadway, or for widening roads already made, powerful displacement plows with tractors, and various types of rotary plows, are employed. Operating costs are lower for truck plows than for tractor plows. Newly fallen snow to a depth of 9 in., and short sections of snow recently drifted but not packed or crusted, can be efficiently removed with truck plows. The Department observes that snow rarely falls at one time to a depth greater than 9 in.; indeed, the greater number of storms deposit only from 2 to 5 in. of snow. Storms depositing 5 and 7 in. or more are comparatively rare.

Costs of snow removal vary in different localities. The frequency, general direction and strength of the prevailing winds are important factors. An area in such a position as to be protected from heavy winds, or having its main roads parallel with the general direction of the wind, may keep the cost of snow removal to the minimum. Areas in open country with main roads running in a direction that makes drifting inevitable, may have much heavier costs. Whether the snow is moist or dry is another cost factor, dry snow being naturally cheaper to remove. Snow falling to a depth of 7 in. without wind can be removed at low cost before it has settled or become packed.

An Incline Mounted on a Rubber-Tired Trailer is used by the maintenance department of the California Highway Commission for removal of slides. Material in the slide is elevated from the roadside to dump-body trucks in a slip

scraper operated by a Fordson tractor. A cable is passed through a sheave in the headframe, the tractor pulling the load up the slide where it trips automatically into the waiting truck. This device, which is made of roadside timber, is particularly valuable because of its mobility.

Traffic Flow Fixes Road Routes in New Jersey

Recently Submitted State Highway System Plan Costing $163,000,000 Based on Traffic Flow Studies

By W. G. Sloan
State Highway Engineer of New Jersey, Trenton, N. J.

From report submitted to New Jersey State Highway Commission on a comprehensive state highway system as ordered by a senate concurrent resolution in New Jersey Legislature, 1926.

A COMPREHENSIVE state highway system should conform to existing and probable future traffic flows; its capacity should be based on careful analysis and must also meet peak requirements; it should be as direct between its termini as is consistent with costs and economical operation, with due concern for traffic requirements of intermediate points; it should be so located in reference to centers of population that local traffic will not follow it to a point where its capacity for through traffic is impaired and local traffic is inconvenienced; it should be so located, constructed and maintained as to meet the requirements for economic operation, including type of surface gradients, curvature, elimination of grade crossings and other sources of danger and delay.

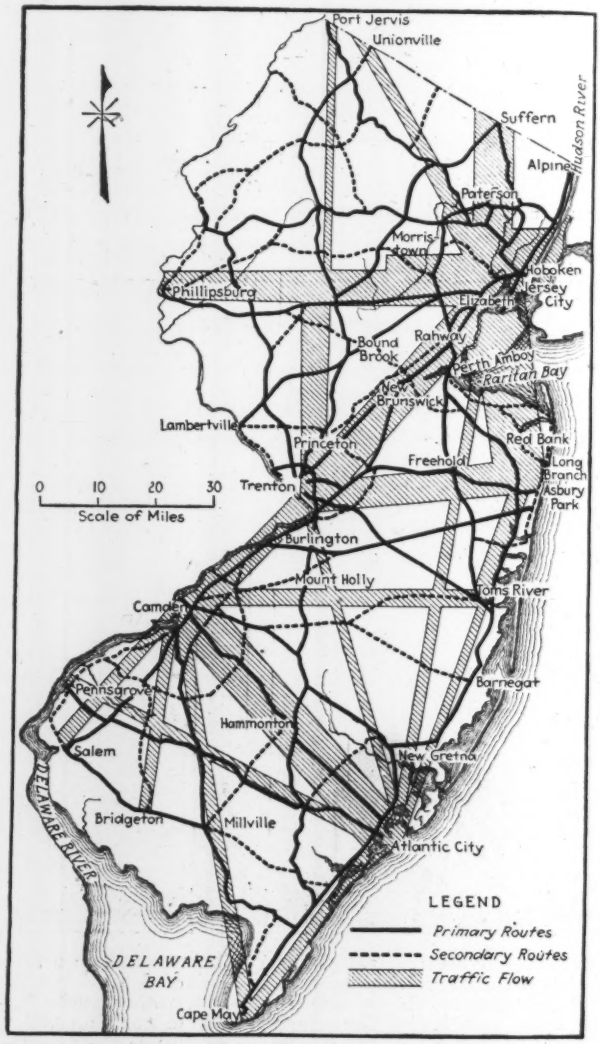
There is a tendency for a flow of traffic between certain points and it is to accommodate this flow of traffic that our highways are laid out. On the accompanying map of the state of New Jersey certain areas are shaded in order to show these traffic flows; the width of the shaded area indicates approximately the magnitude of the traffic flow. These traffic channels all appear to fall within one of two groups: (1) The inter-city traffic and (2) the seashore traffic.

The first group may be subdivided into: (a) New York and the cities of Jersey City, Newark, Paterson and Elizabeth to Philadelphia. (b) Inter-communication between the cities of (a) and Camden, Trenton, Easton, Port Jervis and Suffern. (c) Metropolitan District traffic including all that between New York, Jersey City, Newark, Elizabeth, Paterson and Passaic and such points as Perth Amboy, New Brunswick, Plainfield, Morristown, the Oranges and Montclair. (d) South Jersey traffic to Philadelphia, reaching such points as Burlington, Mount Holly, Hammonton, Millville, Bridgeton and Salem.

The second group may be sub-divided into: (a) Traffic to the seashore resorts in the vicinity of Asbury Park, (1) New York and metropolitan New Jersey, (2) Trenton and vicinity, and (3) Philadelphia and vicinity. (b) Traffic to Atlantic City, (1) Philadelphia and vicinity, (2) New York and Metropolitan New Jersey, and (3) Trenton and vicinity. (c) Traffic to seashore resorts in Cape May County, (1) Philadelphia and vicinity, and (2) New York, metropolitan New Jersey and Trenton.

It would seem that most of the through traffic may be segregated into traffic districts which should be kept distinct and separate as far as possible. If it is made easy and inviting for traffic in one district to pass through or mingle with that in another district there will follow needless congestion. Independent highways, therefore, should carry each group of traffic into a terminus if it be common to both, and where traffic from one district necessarily crosses that of another, such provision for the elimination of the danger and delay incident to a grade crossing should be made as the volume of traffic justifies.

The New Jersey state highway system as recommended is shown superimposed upon the traffic flow map from which it is noted that a proper segregation of traffic of one district from that of another has been carried out to the extent possible. It is possible to defeat the purpose of economical transportation by making through routes accessible to each other and to other minor routes at too many points. Complete segregation is not possible at reasonable cost, nor desirable.



RELATION BETWEEN TRAFFIC FLOW AND PROPOSED NEW JERSEY STATE ROAD SYSTEM

A summary shows that in the metropolitan area there would be 128 miles, of which 100 would be new construction. In the Camden terminal area there would be 13 miles, of which ten would be new construction. In the Trenton terminal there would be 27 miles, with 17 of them new construction. Primary routes not included in these three districts would have a mileage of 1,074 with 640 miles new construction.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Reproduction-Cost-New Theory

Sir—I read with interest the news item and editorial comment in your issue of Dec. 2, 1926, pp. 923 and 895, on the recent U. S. Supreme Court decision in the Indianapolis Water Co. case. I am glad to see you point out that here again we have "merely an indication of a tendency and not a citing of a rule" because the impression is too general that the rulings of the Supreme Court of the United States are, without qualification, in favor of the "reproduction-cost-new" theory of valuation, which is not the fact.

There can be no question as to the competency and importance of reproduction cost as evidence of the value of a property but it need not be and usually is not accepted as the final and only measure of value, nor should current prices necessarily control in determining reproduction cost. There should be a proper weighing of all criteria of value relevant to the particular property and to the particular conditions obtaining at the time the sale or the rate is to be made. If it were a valid principle that public utility valuations for rate-making purposes should be based on the cost of reproduction at current prices, then it should be applicable alike during low price as well as during high price periods. I think it will generally be admitted, however, that it would be an injustice to the owners of a public utility should its rates, during a period of low commodity prices which has but lately followed a period of high commodity prices (and such cycles are inevitable) be determined on the basis of reproduction cost as of date, when the utility, presumably created in response to a public need, had been built only a few years before during a period of high prices. Such a principle, it seems to me, violates sound economic policy with respect to public utilities, which are not identical with private businesses not under public control, and is bound to work an immediate injustice to the utility owner, or to the rate-payer, depending on the then status of commodity prices.

About four years ago, in reporting upon the value of a water system whose purchase was being considered by a western city, I presented a brief discussion of the reproduction-cost method of valuation in respect of that property. A few excerpts from that report may be of interest in connection with the present discussion.

"In the absence of specific stipulation to the contrary, reproduction-cost as a measure of value is usually estimated on the basis of prices taken over a period sufficiently long to average or level off abnormal price conditions.

"The reproduction-cost method of valuation came into vogue at a time when a considerable element of the public believed that the then railroad rates were based upon inflated property values of the past and validity for the method was claimed upon the theory that, in the absence of definite, dependable book records as to actual unit prices and actual costs, it afforded a fairly practical way of arriving at what was being sought, namely, the probable bona-fide investment in the property as a basis for rate-making. It probably would not have come into vogue during a period of inflated prices, nor during a period of great price fluctuation, and although it is widely used today in appraisal work, and properly so, its finding of value is not regarded as necessarily conclusive and, in particular, few would contend that a short, peak-price period was a proper basis for determining the true value of a property.

"As indicating the trend of opinion of public service commissions respecting the weight that should attach to reproduction-cost valuations, based upon the high prices that have prevailed during the past few years, there is quoted below a notation in the dissenting opinion of Justices Brandeis and Holmes, of the U. S. Supreme Court in the Southwestern Bell Telephone Co. case, as reported in the June 7, 1923, issue of Public Utilities Reports:

"'The Public Utility Reports for 1920, 1921, 1922 and 1923 (to March 1) contain 363 cases in which the rate-base or value was passed upon. Reproduction cost at unit prices prevailing at the date of valuation appears to have been the predominant element in fixing the rate base in only 5. In 63 the commission severely criticized, or expressly repudiated, this measure of value. In nearly all of the 363 cases, except 5, the commission either refused to pay heed to this factor as the measure of value, or indeed as evidence of any great weight.'

"The transfer of a public utility property would ordinarily be impractical on such a basis and, except in the case of an involuntary or compulsory transfer, would not in fact be made. An attempt to effect a transfer on that basis would defeat itself, and rightly, because it would violate economic principle. Regulatory commissions, as clearly shown by the quotation above, are disinclined to permit rates to be based upon such inflated valuations. If the principle were admitted that the value of a public utility property followed the cost of reproduction at prices as of current date, then changes in the rate-base and in ratios would be sought for every important fluctuation in commodity prices, would be sought either by the owner of the utility or by the rate-payer, depending upon the fortuitous circumstance of which way the swing in prices went.

"There must be dependable stability in returns to give value to a property and to make possible its efficient operation and maintenance. Changes in rates cannot ordinarily be extreme and convulsive; they must be orderly and sufficiently moderate to permit both the utility and the consumer to make adjustment to the change without undue shock. It would indeed be a dangerous precedent, for both the owner and the rate-payer, to subject a public utility property to the hazard of the sudden and frequent change in rate-base and rates that this theory of current-price, reproduction-cost valuation necessarily imposes.

"The service that a public utility renders is not sold like an ordinary commodity of commerce. The latter is usually purchased for immediate sale and the current or momentary market price controls both in the purchase and in the early resale of the commodity. The former, however, is sold over an indefinite period in the future and the purchaser of a public utility property, therefore, must consider what average price is likely to obtain for the service he sells over a fairly long period ahead, i.e., what average earnings will he be able, or be permitted by the regulatory control, to make in the future.

"No prudent purchaser would ignore such considerations. Rates, earnings and value are closely interrelated. This property must, or ought to be continuously operated on a basis of earnings that are in accord with economic principles and it will at all times be subject to such regulatory control as the state may impose, or the city itself, should the utility pass to that ownership. It is entirely unlikely that any regulatory commission would permit, or that the public would willingly accede to, rates that would yield a fair return on a valuation wherein preponderant weight was given to a peak-price reproduction cost of a property the major portion of which was built during a period of low prices, as was the property now under consideration."

Seattle, Wash., Dec. 9, 1926.

JOSEPH JACOBS,
Consulting City Engineer.

Protection of Hydrants From Frost Below Ground

Sir—I was interested in the letter from F. A. Waterous, in *Engineering News-Record*, on p. 920, Dec. 2, asking "how can freezing of fire hydrants below ground-water level be prevented." We have had this problem before us every winter, as some of our properties have a ground-water level, which is perennially close to the surface.

Last winter we adopted a system of protection for hydrants which proved quite satisfactory and was inexpensive. The water was pumped out of the casings and the cavities were filled with crude oil to the ground-water level. In the spring the water is turned on and the oil is simply washed out, which should be done carefully to avoid splashing the surroundings with oil.

We did not have a single frozen hydrant last winter, and had no trouble with the rubber diaphragms or washers, as the valves were shut and the crude oil did not come in contact with rubber.

Dec. 14, 1926.
Toronto, Ont.,

H. E. P. DUNCAN,
Engineer of Structures, Toronto Transportation Commission.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Governor Smith Urges Huge N. Y. Road Program

Would Have State Spend $112,000,000 on Reconstruction, $160,000,000 on New York State Highways

(*Special Correspondence*)

A program of road repair and rebuilding of bridges at an ultimate cost of nearly $300,000,000, and for which a further bond issue will undoubtedly be necessary is predicted in the annual message of Governor Smith to the New York State Legislature in the section devoted to highways. The Governor says:

"Twenty years ago, when the first bond issue for good roads was suggested no person had reason to believe we would experience such an enormous growth in the number of vehicles travelling upon these highways. Certainly at that time we did not anticipate the heavy truck now used to promote trade and commerce throughout the state. Consequently, many of the roads built and designed in the early stages of our program of road construction are now entirely inadequate. In years gone by a majority of our pavements were built 16 ft. wide. Many are only 14 ft. and there is a considerable mileage having pavements 12 ft. or less in width. It goes without saying that these roads are entirely unfit for modern usage, not to make any mention whatever of our future needs. We are now building even less important roads to a width of 18 ft. and on main lines we build our roads 27 ft. wide. In addition to being too narrow, our older roads, which constitute more than half of the total state mileage, were built for horse-drawn traffic, designed before motor trucks were thought of. Many of them are only 6 to 8 in. in thickness. They are completely worn out and to continue to patch them year after year is a waste of money. They should be rebuilt with modern durable pavements. The Superintendent of Public Works reports to me that there are 2,460 miles of worn-out roads which should be rebuilt during the next five years and the superintendent estimates this reconstruction will cost $112,000,000.

BRIDGE RECONSTRUCTION

"On Jan. 1, 1926, the state took over from the towns the responsibility of rebuilding all bridges on the state highway system condemned after that date. There are now 514 bridges that should be rebuilt without delay. To do this will cost $12,000,000, of which the state must pay 65 per cent, or $7,800,000.

"This, briefly is our highway situation so far as it covers reconstruction of old roads and rebuilding of condemned bridges; but on top of this we have 3,700 miles of new highways not under contract which are to be built in order to complete the present adopted system. It is estimated the state's share in the cost of these new roads will be $160,000,000.

"It also seems evident that there is an obligation upon the state to continue its program of road widening in the counties adjacent to the large cities, particularly in Erie and Nassau counties. These highways are not new roads and not a part of the highway system as adopted, but the reason for widening them is obvious. The cities are building wide boulevards leading out into the country and when you arrive at the city line, a 100-ft. road emerges into a 14-ft. one, creating a bottle neck and adding to the congestion and the danger in handling automobile traffic on the border lines of these cities.

"Just as the state has faced other problems of great magnitude and requiring a great outlay of money, it must face the highway problem."

Engineering Fifty Years Ago

From *Engineering News*
Jan. 6, 1877

LAST Friday, Dec. 29, the Pacific Express on the M.S. and L.S.R.R. consisting of two engines, four baggage and express cars, two ordinary coaches, one smoking car, one palace car and three sleepers, in the order named, left Erie at 5 p.m. one hour and eight minutes late and was due in Ashtabula at 5:13 p.m. After working through the snow it arrived at Ashtabula bridge a few hundred feet from the bridge at about 7:30 p.m. and with a velocity of from 10 to 12 m.p.h.

When the head of the train had nearly reached the farther end of the bridge this structure gave way from some cause yet unknown and the entire train except the forward engine, which crossed in safety, was precipitated into the ravine of Ashtabula Creek, falling about 75 ft., and in a short time thereafter being entirely consumed by fire. The number of passengers on board has been variously estimated from 130 to 300. . . . The account so far as made out by the railway officials . . . gives the number of killed as 80.

The bridge was a double-track, overgrade structure, a single span of 157 ft., Howe truss type, built in iron, having two truss systems.

St. Lawrence Route Favored by Hoover Commission

United States St. Lawrence Commission Endorses Earlier Report of Board of Engineers

A favorable report upon the proposed St. Lawrence River shipway has been made to the President by Secretary Hoover, chairman of the United States St. Lawrence Commission, a commission appointed by the President in March, 1924, to advise upon the development of a shipway from the Great Lakes to the sea. The chief function of this commission was to study and report upon the St. Lawrence shipway, but in order to do this adequately it has also had to consider the advantages of the proposed Great Lakes-to-Hudson canal to present comparative figures.

(Abstracts of the favorable report of the Joint Board of Engineers set up by the United States and the Canadian governments upon the St. Lawrence shipway and of the adverse report of the Chief of Engineers, U. S. Army, upon the Great Lakes-Hudson canal, were given in *Engineering News-Record* of Dec. 2, p. 906, and Dec. 16, p. 1002.)

FREIGHT MOVING COSTS

The commission has found that the increase of freight rates over ocean rates since the war and the opening of the Panama Canal have worked to the economic handicap of a vast portion of the interior of the North American continent, a disadvantage which could be offset in part by the construction of a shipway from the Great Lakes to the Atlantic Ocean. Of the three routes proposed, the commission gives the following costs per ton of freight moved: For the so-called All-American Route, by means of a canal through New York State around Niagara Falls and another canal from Lake Ontario across New York State to the Hudson River at Albany, $2.06 per ton; for the same route except that the Welland Canal is used instead of the new canal around Niagara Falls, $1.64 per ton; and for the St. Lawrence route, $0.43 per ton. The Department of Commerce estimates that the maximum tonnage to be expected for the Great Lakes-Hudson Canal is 20,000,000 tons per year and for the St. Lawrence Canal, 25,000,000 tons.

The commission restates the comparative cost figures given in the earlier reports by the engineers as $506,000,000 for the Lake Ontario-Hudson route; as $631,000,000 for the same route with the canal around Niagara Falls added (both estimates without interest during construction), and $123,000,000 to $148,000,000 as the *net* cost to the joint governments of the St. Lawrence route if developed in the following manner: First, that some of the private or public bodies now

proposing to develop power in the international section of the St. Lawrence River be authorized to undertake that work. By the construction of locks and canals around such power development at an estimated cost of from $22,400,000 to $34,000,000 and an additional $3,000,000 for channel improvement, a shipway for 141 miles of the 183 between Lake Ontario and Montreal will be provided. In the remaining 42 miles where there is no apparent economic demand for all the power, the commission proposes that either an independent canal be built or a combined canal and power development with 400,000 hp. immediately available and provision for 2,350,000 hp. later on. The first alternative would cost about $97,500,000 and the second, $161,000,000. The capital value of the power on the latter scheme is placed at $50,000,000, an amount not chargeable to the net cost.

On the subject of power in the international section, the commission states: "On the American side, the state of New York has a special interest in the power development of the international section and the co-ordination of these improvements with the state should be undertaken. Owing to the navigation and international character of the river, the federal government has an interest and must necessarily assent to and negotiate power development questions from the American side." Further, the commission states that "The development of these vast power resources is inevitable in the interests of the population of that region. Their development will eventually create a shipway on this route even if other routes were undertaken."

The commission summarized its findings in the following conclusions: "First, the construction of the shipway from the Great Lakes to the sea is imperative both for the relief and for the future development of a vast area in the interior of the continent; second, the shipway should be constructed on the St. Lawrence routes, provided suitable agreement can be made for its joint undertaking with the Dominion of Canada; third, the development of the power resources of the St. Lawrence should be undertaken by appropriate agencies; fourth, negotiations should be entered into with Canada in an endeavor to arrive at agreements upon all these subjects. In such negotiations the United States should recognize the proper relations of New York to the power development in the international section."

Japan to Build Undersea Railway

Definite plans have been adopted for the construction of the Japanese Government railway tunnel under the Moji-Shimonoseki Straits, states a report from Consul Henry B. Hitchcock, Nagasaki, made public by the Department of Commerce. Work was to have commenced during 1924 or 1925 but the funds authorized for the purpose were diverted to other uses as a consequence of the earthquake of 1923. Under the present plan work is to begin during 1928, and the tunnel is to be finished by 1933. The total cost is estimated at 20,000,000 yen ($10,000,000).

Propose $25,000,000 Bond Issue for California Road Structures

The biennial report of the California Highway Commission issued late in December carries recommendations for a state bond issue of $25,000,000 to improve the existing situation as to needed bridges and grade-separation structures. The state highway engineer's estimate calls for $15,000,000 "to provide suitable bridge structures on the present highway system of proper strength and width to care for the present and a reasonable increase in traffic." The remaining $10,000,000 is for the state share in much needed grade separation.

W. W. Brush Now Chief Engineer of New York Water Department

On Jan. 1, W. W. Brush was advanced from the position of deputy chief engineer to that of chief engineer of the Department of Water Supply, Gas and Electricity, New York City, succeeding the late Col. Merritt H. Smith who died Dec. 8, 1926. Mr. Brush has been connected with the water supply of New York City since graduation in civil engineering from New York University in the middle 90's. From 1894 to 1897, he rose from chainman and leveler to be assistant engineer of the water-works, of what is now Brooklyn borough. From 1907 to 1909, he was assistant and department engineer with the Board of Water Supply of New York City, which board built the Catskill aqueduct and appurtenances. In 1910, he became deputy chief engineer of the Department of Water Supply, which operates the water-works of the five boroughs.

For a number of years Mr. Brush has been treasurer of the American Water Works Association.

Proposals for N. Y. State Power Authority Made by Governor

In his message to the New York State Legislature, Governor Smith has made definite recommendations concerning his plans for state development of its water power resources. On this subject he said, in part:

"We need a comprehensive plan developed by a public agency in which the people have confidence, and this agency should be capable of securing and administering capital for the construction and operation of such public undertakings. I therefore propose the creation of a Power Authority as a body corporate and politic, vested with ownership and control for the state of all water power resources belonging to the state. This will not be a new or separate department any more than the Port Authorities of New York and Albany are considered state departments. They are agencies of the state and the Power Authority which I propose will hold the same position in our government.

"The Power Authority should be empowered to issue its own tax exempt securities for the development of such power enterprises as they can successfully demonstrate have economic value. It should also be required to report to the legislature at the earliest possible moment a comprehensive legal, financial and engineering plan for the development of the water power resources of the state. Until the plan is adopted by the legislature the Power Authority will have no right to proceed. Once the plan has been adopted, the Power Authority can proceed to finance the projects by the issuance of its own securities. Legislative control is safeguarded by conditioning the exercise of the powers of the Power Authority upon its own approval of such a comprehensive plan, following the precedent the legislatures of New York and New Jersey adopted in dealing with the Port of New York. Until such time as the comprehensive plan has been adopted by the legislature, an expenditure of $100,000 will settle the question for all time.

"Such an organization has the advantage of providing money for development at lower rates of interest than private capital can be enlisted and this must in the end influence the rates for final distribution to consumers. The Port Authority of New York has in the last year issued and successfully sold thirty-four million dollars of its own bonds to finance two bridges at 4½ per cent. Its second issue of twenty million dollars sold at a lower rate even than the first, showing the growth of public confidence in such undertakings.

"The Power Authority should also be enabled to represent the state in the important negotiations that must be conducted with other states, the Federal Government and with Canada."

Engineers to Review San Gabriel Flood-Control Plan

A board of three engineers was appointed Dec. 27 by the Los Angeles County board of supervisors to examine, study and report on the present program of the county flood-control district with respect to the San Gabriel River.

After a proposed bond issue of $26,000,000 for further county flood-control work was voted down at the November election by a heavy majority, the board of supervisors asked for recommendations from the Los Angeles Chamber of Commerce in connection with further work on the flood-control program. The Chamber of Commerce in co-operation with the Southern California Section, Am. Soc. C. E., the Clearing House Association, the California Taxpayers' Association and the Municipal League advised the appointment of the Engineering Board of Review. The engineers appointed are F. H. Fowler, consulting engineer, San Francisco; C. D. Marx, Stanford University; and Charles H. Paul, consulting engineer, Dayton, Ohio.

The recommended compensation for the engineers was placed at $25,000 to $30,000 with "allowance for unavoidable delay."

An article on the Los Angeles County flood control situation was published in *Engineering News-Record*, June 3, 1926, p. 890.

Cleveland Man Wins A.R.B.A. Prize Contest

S. H. Murdock, construction engineer of Cleveland, Ohio, won the national engineer's essay contest conducted by the American Road Builders' Association. Mr. Murdock will be a guest of honor at the annual convention and road show of the association, Jan. 10 to 15 at Chicago.

The winner of the second award was Harold Tilton, resident engineer of the Massachusetts State Department of Highways. The third paper selected was written by J. J. Forrer, maintenance engineer for the Virginia State Department of Highways.

The purpose of the competition was to seek out new methods of highway construction, maintenance or finance which may have been successfully used in various parts of the country.

Eight Toll Bridges Projected in Indiana

(Special Correspondence)

If it is impossible to secure adequate bridge construction in Indiana out of public funds, it begins to appear that bridges will be built anyway. Eight toll bridges are projected by private parties, with the expectation that when they have paid for themselves they will be turned over to the counties or the state at a fraction of their original cost.

Articles of incorporation have been filed with the secretary of state of Indiana by the Lawrenceburg-Kentucky Bridge Co., Lawrenceburg, (Ohio. River); McCarmel-Princeton Bridge Co., Princeton, (Wabash River, Gibson County); Evansville-Henderson Bridge Co., Evansville (Ohio River, Evansville); Vevay-Ghent Bridge Co., Vevay, (Switzerland County); Hawesville-Cannelton Bridge Co., Cannelton, (Perry County); Wabash Bridge Co., Vincennes, (Wabash River, at Vincennes); Louisville-Jeffersonville Bridge Co., Jeffersonville, (Ohio River, Jeffersonville), and Owensboro-Rockport Bridge Co., (Daviess County). The name of E. W. Norris of Toledo, O., appears as one of the directors in each of the eight companies.

Reinforcing Steel Institute Announces Activities

The preparation of a book of standard specifications for reinforced-concrete construction, supplemented by information as to standard sizes of bars, and proper placing of reinforcement is to be undertaken by the Concrete Reinforcing Steel Institute, as a result of recommendations adopted by the directors. An engineer is to be appointed also to study methods of handling and placing reinforcing bars and to prepare specifications for such work. Plans are being made for a meeting of manufacturers, distributors and users of bars to decide upon some one uniform grade of steel for bars. Other activities are a study of engineering costs and an attempt to check the use of imported bars. The annual meeting will be held at White Sulphur Springs, W. Va., on March 21 to 23.

"Journal of Electricity" Changes Name to "Electrical West"

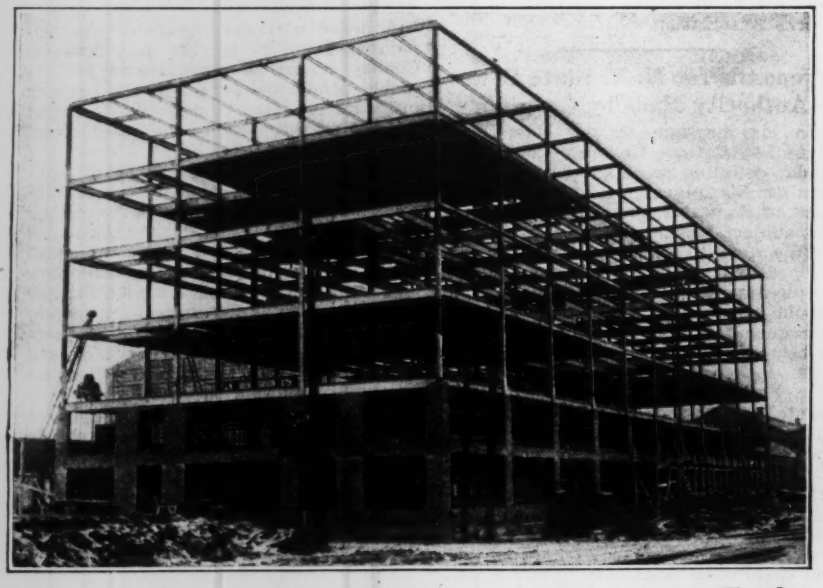
On Jan. 1, 1927, the *Journal of Electricity* changed its name to *Electrical West*. Serving as it does the electrical industry of the eleven western states, the new name will more closely define the field and the function of the paper. Beginning with the January, 1927, issue, *Electrical West* will be published monthly, on the first of the month, instead of semi-monthly.

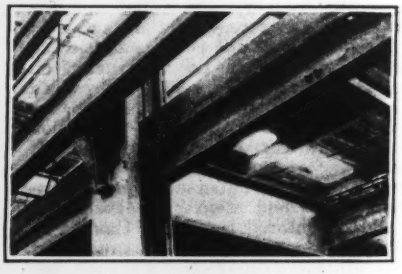
The *Journal of Electricity* was founded in 1887 and has now served the special needs of the electrical industry of the West for almost 40 years. It has been the medium for the development and the interchange of ideas and plans through every period of the outstanding engineering and commercial achievements of that section. Under its new name, *Electrical West*, the publisher, the McGraw-Hill Publishing Co., Inc., says that this tradition of service will be faithfully upheld and that editorial plans call for even more particularized attention to the special needs of this great electrical empire of the West.

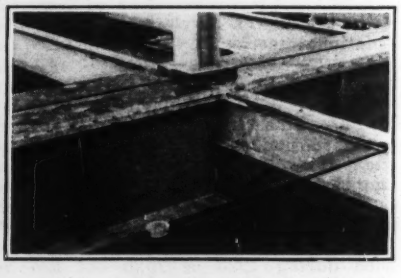
Augusta-Greenwood Line Authorized

The Interstate Commerce Commission has authorized the Georgia & Florida Railroad Co. to construct its proposed line from Augusta, Ga., to Greenwood, S. C. Construction is to be begun before July 1, 1927, and to be completed before July 1, 1929.

Five-Story Arc-Welded Building Inspected







The five-story structural steel building, planned from its inception specifically for arc-welded construction, which is now approaching completion at the Sharon, Pa. plant of the Westinghouse Electric & Mfg. Co., was inspected Dec. 15 and 16 by several hundred architects, engineers and contractors. The floor dimensions of the building are 70x220 ft.; the height will be 80 ft.

It is pointed out that in designing the building for welded construction a reduction in steel from a total of 800 tons to 700 tons was effected. A feature in connection with the labor supply was that three weeks' training had converted riveters into satisfactory operators of welding equipment. Steel for the structure was fabricated in the plant of the American Bridge Company, at Ambridge, Pa.

M. I. T. Organizes Municipal and Industrial Research Division

Organization of a division of municipal and industrial research at Massachusetts Institute of Technology, for the application of engineering knowledge to the problems of government, industry and commerce is announced by President Samuel W. Stratton.

The division was founded through the generosity of John E. Aldred, New York banker and industrialist, who was one of the first to recognize the need for an organization qualified to investigate the involved problems of community, industrial and commercial activities, and their relation to one another.

Undertakings in prospect for the new organization include such important tasks as surveys of industrial development, rail and water transportation facilities, studies of raw materials, products and markets, power facilities, and the problem of urban and interurban traffic regulation in relation to the social and business activities of the community.

In its service to governmental units, including states, counties, cities and towns, the division will cover the broad field of public works with problems of city and town planning, traffic regulation, zoning, and the relation of municipal facilities to industrial and social expansion.

The new work will be in charge of Prof. William A. Bassett. Professor Bassett has had twenty-five years of experience in municipal engineering. He is a graduate of Harvard in the class of 1901, and in addition to experience in the field of design and construction, has been consultant for numerous governmental units. In connection with this work, while he was an associate on the staff of the New York Bureau of Municipal Research, he made investigations in New York State, South Dakota and Virginia and for the cities of New Orleans, La.; Camden and Newark, N. J.; Charleston, S. C., and Richmond, Va.

The Providence R. I. Chamber of Commerce has been requested, in a resolution passed recently, to retain the services of the new division to assist in an advisory capacity in a proposed industrial survey of Providence and its environs.

Foss Head of McGraw-Hill Book Co. as Caldwell Resigns

Edward Caldwell has resigned from the presidency of the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City, and will retire from active business. Mr. Caldwell has been associated with the McGraw-Hill interests for thirty-six years. He was one of the organizers of the McGraw-Hill Book Co., Inc., in 1909 and has been active in its management since its formation. Mr. Caldwell will remain on the boards of directors of the McGraw-Hill Book Co., Inc., and the McGraw-Hill Publishing Co., Inc.

Martin M. Foss, who was associated with Mr. Caldwell in the organization of the McGraw-Hill Book Co., Inc., has been chosen to succeed Mr. Caldwell as president.

Three Ohio River Bridge Bills in Congress

Bills pending before Congress would give Congressional authorization to three new Ohio River bridges. One of these crosses from Gallipolis, Ohio, to the West Virginia bank (Gallia County Ohio River Bridge Co.); another from Coal Grove, Ohio, to Ashland, Ky. (Ashland Bridge Co.); and the third from Aberdeen, Ohio, to Maysville, Ky. (Maysville Bridge Co.).

A bill authorizing the Chesapeake Bridge Co. to construct a bridge from a point in Baltimore County, Md., near the mouth of Back River to a point in Kent County, between Rock Hall and Tolchester Beach, is also pending.

Great Northern Ry. to Acquire Inland Empire Lines

Negotiations for the purchase of the 180-mile electrically-operated system of the Inland Empire R.R. Co., including its subsidiary the Spokane & Eastern Ry. & Power Co., have been made by the Great Northern Ry., subject to the approval of the Interstate Commerce Commission. The purchase price has not been announced, but the reproduction value of the property is given as about $16,000,000. The Inland Empire lines, centering at Spokane, Wash., extend south to Colfax, Wash., and Moscow, Idaho, and east to Coeur d'Alene and Hayden Lake.

Washington Notes

DEVELOPMENT of the Holston River as proposed by the Holston River Power Co., in the opinion of the Chief of Engineers, provides for a more comprehensive utilization of the river's resources than does the plan submitted by the Tennessee Eastern Eelctric Power Co., it is understood. The application of the Holston company has been before the commission since Dec. 2, 1922, but its consideration has been delayed awaiting data being gathered in the course of the survey of the Tennessee River.

THE International Paper Co. of New York has applied to the Federal Power Commission for a preliminary permit for a power development on Ravillagigedo Island, Alaska. This application conflicts with those previously filed by William Randolph Hearst, Mark L. Requa, George T. Cameron, Thebo, Star & Anderton, and by the Alaska Pulp and Paper Co.

Apparently the newspapers and the news print interests represented by the applications have concluded that conditions are particularly favorable on Revillagigedo Island for the manufacture of paper and pulp. Since the applicants first must secure a timber license from the Forest Service, the conflict will be settled before that agency rather than before the Federal Power Commission. The Power Commission probably would grant the power license to the interest holding the timber rights.

New Jersey Institutions Sponsor Sewage Plant Operators' Course

From Jan. 17 to 28, 1927, there will be held at Rutgers University, New Brunswick, N. J., the first annual short course for sewage plant operators. The course will be under the direction of the college of engineering in co-operation with the New Jersey Sewage Works Association and the New Jersey State Department of Health. Enrollment is not confined to residents of New Jersey. There will be a registration fee of $5 and various minor expenses which will bring the total estimated cost to non-resident students (those who do not travel back and forth by automobile or train) to $15 for the two weeks.

The course is designed primarily for the operator and has particularly in mind affording an opportunity for those who wish to obtain sewage-works operating licenses from the State Board of Health—a condition precedent to taking such positions in New Jersey.

Inquiries for further information regarding the course should be sent to Edward H. Rockwell, dean, Engineering Department, Rutgers University, New Brunswick, N. J. Those directly in charge of the course for the university are Harry N. Lendall, professor of municipal and sanitary engineering, and P. A. van der Meulen, professor of general and physical chemistry.

Denver's Water and Flood Projects Wait Action

With the franchise for the Public Service Co. under active consideration at Denver, Colo., for the past six months, the flood-control project and water-supply problem have been shelved. No action has been taken on the flood report of the Colorado Engineering Council and little has been said about it in the local papers. During 1926 the runoff of the South Platte River was about 140 per cent of normal, and while there was no flood or even high-water stage this supply quieted the talk about a water famine.

No steps have been taken toward leasing the water tunnel from the Moffat Tunnel Commission as a part of the city's water supply system. In the proposed franchise for the Public Service Co., provision has been made for the purchase of any municipal hydro-electric energy incident to the city's water-supply developments. This franchise will come to a public vote on Feb. 8.

Lake Champlain Bridge Location Is Selected

After investigation of a number of proposed sites for a bridge across Lake Champlain to connect New York and Vermont, the commission appointed by the two states for the purpose has decided to recommend the location from Chimney Point to Fort Frederick. This involves a crossing of about 1,100-ft. length, estimated to cost $800,000, of which sum it is proposed 60 per cent should be borne by New York State and 40 per cent by Vermont.

Personal Notes

B. W. MOLIS, assistant signal engineer of the Rock Island Lines, at Des Moines, Iowa, has been appointed signal engineer of the Denver & Rio Grande Western R.R., with office at Denver, Colo.

RAY DUNLAP, division engineer of the Missouri State Highway Commission, with headquarters in Joplin, Mo., has been promoted to engineer in charge of the bureau of construction in the general offices of the commission at Jefferson City. He succeeds THOMAS H. CUTLER, the new chief highway engineer of Missouri.

J. H. THOMPSON, JR., formerly vice-president and secretary of the Gunite Concrete and Construction Co., is now vice-president and J. Q. A. GREENE, formerly treasurer and field manager is now secretary and treasurer. BARCLAY A. GREENE remains as president as also does the balance of the organization as heretofore.

F. B. FREEMAN, chief engineer of the Boston & Albany R.R., has resigned. Mr. Freeman came to this country from Ireland in 1892 and after being in private practice and in the bridge department of the Erie R.R. for a few years he entered the service of the New York Central R.R. in August, 1900, first becoming assistant engineer in charge of construction and later engineer of construction, which position he held when he was appointed chief engineer of the Boston & Albany R.R., a subsidiary of the New York Central, in 1909. G. A. Kirley, signal engineer of the Boston & Albany, has been appointed chief engineer to succeed Mr. Freeman. Mr. Kirley is a graduate of the University of Michigan in the class of 1907. He entered the service of the New York Central as a draftsman in the signal department upon graduation from college and two years later was transferred to the signal department of the Boston & Albany, where he served as chief draftsman, assistant engineer, and recently signal engineer.

E. D. BUEL, chief engineer of John Monks & Sons, contractors and engineers, New York City, has gone to Porto Rico with part of the company's engineering force, this company having been retained by the Celotex Co. to make surveys of the port of San Juan and other sites on the island, where plants for the manufacture of celotex insulating lumber will be located.

FREDERICK A. DAVIS, landscape architect, has been appointed engineer for the city plan commission of New Haven, Conn. The engineering work of the commission was formerly done by the city engineer of New Haven.

J. ROBERT WELSH, engaged with the L. E. Myers Co., of Chicago, Ill., was recently made construction engineer for this company in building the Weleetka power station in Oklahoma. Mr. Welsh has been with the company for the past three years, first as construction engineer on the Dix River dam project and later on preliminary investigations on several water-power sites in Wisconsin.

Engineering Societies

Calendar

Annual Meetings

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention and Road Show, Chicago, Ill., Jan. 10-14, 1927.

AMERICAN ENGINEERING COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 12-15, 1927.

SOCIETY OF AMERICAN MILITARY ENGINEERS, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 17, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 19-21, 1927.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, Asheville, N. C., Jan. 24-28, 1927.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Quebec, Feb. 15-17, 1927.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 22-24, 1927.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, Ill., March 8-10, 1927.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

The Engineers Society of Western Pennsylvania at its Jan. 4 meeting, the annual meeting of the civil section, had an illustrated talk on the Recent Trend in Sewage Disposal Developed in Design for Fostoria, Ohio, by J. F. Laboon, of the J. N. Chester Engineers, Pittsburgh.

The Montreal Branch of the Engineering Institute of Canada has elected for this year: C. V. Christie, chairman; F. C. LaBerge, vice-chairman; and other officers, J. G. Caron, D. C. Tennant, and D. Hillman.

The New York Section of the American Water Works Association held a luncheon meeting Dec. 29 at which three papers relating to the water supply and works of New York City were read. W. W. Brush, deputy chief (now chief) engineer of the Department of Water Supply, related recent experiences with storage reservoirs at low levels. J. Waldo Smith, consulting engineer, Board of Water Supply, summarized his answer to the New York *Herald-Tribune's* news story about leaks from the Ashokan reservoir (see *Engineering News-Record*, Oct. 28 and Nov. 25, 1926, pp. 719 and 886). Methods of handling water mains in connection with New York subway construction were described by Robert Ridgway, chief engineer, Board of Transportation, New York City.

The Western Society of Engineers lists papers as follows: Jan. 10, "Construction of the Gulf Coast Sea Wall," by Hobart D. Shaw; Jan. 17, "Power Supply for Transportation in Chicago," by H. B. Gear.

The Connecticut Section of the American Society of Civil Engineers at a meeting in New Haven Dec. 11 had an interesting address by Allen Hazen, consulting engineer, New York, on the "Reservation of Catchment Areas for Future Water Supply of Our Cities."

Obituary

J. H. E. SECRETAN, a prominent civil engineer, died in Ottawa, Ont., Dec. 22 at the age of 72 years. He was for many years on the staff of the Canadian Pacific Ry., under Sir William Van Horne and was associated with the construction of the railway. Mr. Secretan subsequently visited the Yukon and wrote several books of a technical and descriptive character which were regarded as authoritative, among them "To Yukon and Back"; "Out West," and "Canada's Greatest Highway."

HARRY P. OTIS, former president of the Norwood Engineering Co., died at his home in Florence, a suburb. He was 73 years old. He was born in Manchester, Conn., and graduated from the engineering department of Massachusetts Agricultural College in 1875.

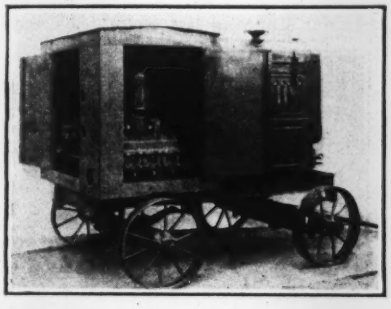
ALEXANDER MAITLAND, president of the Kansas City Bridge Co., member of the firm of Fuller & Maitland, consulting engineers in the construction of the new Kansas City water-works, and a member of the Board of Direction of the American Society of Civil Engineers, died Dec. 24 at his home in Kansas City after an illness of long duration. He was 60 years of age. Mr. Maitland graduated in civil engineering from the University of Missouri and took two years of military training under Maj. Gen. E. H. Crowder, then a lieutenant. Bridge engineering was the major work of his life. He began as a draftsman for the King Bridge Co., Cleveland, Ohio, and later was employed as an engineer and designer of the estimating department of the Keystone Bridge Co. at Pittsburgh, Pa. For several years he was an engineer for the Missouri Pacific R.R. and designed railway bridges, water supply stations, and railway structures of all kinds; and he designed bridges for many other railroads. In 1901 he went to Kansas City as contracting engineer for the Pittsburgh Bridge Co.; later he became contract manager for the American Bridge Co. with headquarters in Kansas City. He was elected president of the Kansas City Bridge Co. in 1903. In 1918 he resigned to do war work of engineering nature for the government, at Washington, D. C., but after the war returned to the presidency of the Kansas City Bridge Co. Besides bridge work, he controlled revetment contracts on the Missouri River. In 1921 he was engaged, with George W. Fuller of New York, for the design and supervision of construction of new water-works for Kansas City. Mr. Maitland was a former president of the Kansas City chapter of the American Society of Civil Engineers. The Kansas City Engineers' Club has adopted resolutions of regret at his death and esteem for his work.

New Highway Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

High Pressure Force Pump for Pressures Up to 600 Lb.

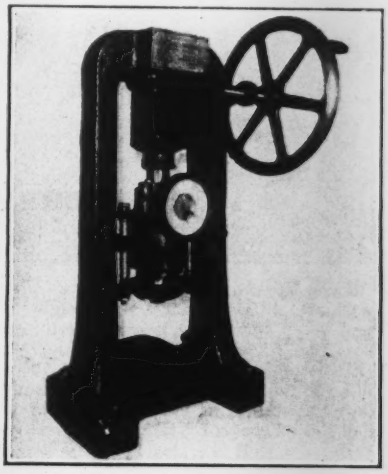
Regularly furnished with a 35-hp. four-cylinder, industrial type engine, mounted on steel wheel spring-equipped trailer, the high pressure force pump illustrated has been developed by the Domestic Engine & Pump Co., Shippensburg, Pa. This new pump is a large capacity, three-cylinder, self-oiling, single-acting plunger pump. Adjustable outside packing glands are used, equipped with compression grease cups so that the packing can be kept properly lubricated. Other special features are force feed oiling of all connecting rod and drive shaft bearings; steel gears, machine cut and running in oil; Hyatt roller bearings on high speed drive shaft; and closed crankcase to keep out all dirt and retain the oil. Oil is forced through drilled holes in the crankshaft. All valves and valve seats are of bronze



and the valve is claimed to be practically self-grinding. Adjustable stops on the valve caps regulate the lift of the valves. The crank gear and intermediate pinion are inclosed in the pump crankcase. The large gear dips in oil, insuring that it is properly lubricated. Maximum working pressure is 600 lb.

New Machine Tests Stability of Asphalt Paving Mixtures

The new stability testing machine, devised by Prevost Hubbard and F. C. Field of the Asphalt Association, not only tests the briquets of asphalt paving mixtures, but may also be used for the compression of the briquet.



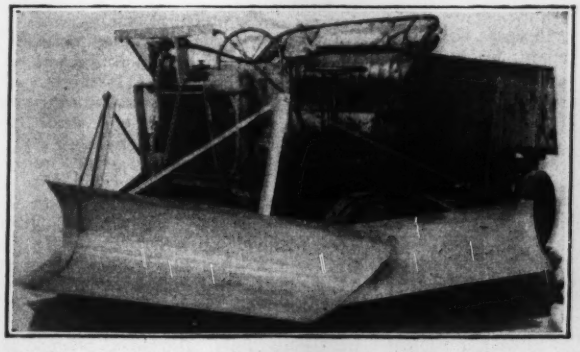
In operating the machine, a helicoidal spring, which is placed in the testing head, is used as a direct measuring device. The testing head is lowered by a hand wheel and the spring deflects directly, no levers being used. Stability is measured by forcing the briquet through an orifice. Under a load of 10,000 lb. there is produced a deflection of $\frac{1}{16}$ in. and a very accurately calibrated dial records the load in increments of 20 lb. It is possible to interpolate readings to 5 lb. The pointer on the dial stops when the maximum load has been reached; the pointer is shifted back to zero by a finger catch.

Flight-Conveyor Snow Loader Has Many Advantages

A new snow loading attachment designed for mounting on its standard creeper chassis has just been developed by the George Haiss Mfg. Co., Inc., New York City. It consists of a steel flight conveyor 33 in. wide, 11 in. high and equipped with cutting teeth. The flights are bent as shown in the illustration to give a correct angle to the cutting edge; they are made of $\frac{1}{4}$-in. steel plate, while the toothed plate riveted to them is $\frac{3}{8}$-in. material. The flights are spaced 24 in. apart.

The first advantage of this snow loader is its large capacity, limited only

to the size of the lump which can be carried without falling over the side of the conveyor. Another advantage is that practically all the snow carried will be discharged and not carried back



V-Type Snow Plow Equipped with Wings—A New Product of Baker Manufacturing Co., Springfield, Ill.

Device Designed by the National Steel Fabric Co., Pittsburgh, Pa., for Installing Its Steel Reinforcing in Concrete Highway Slabs

down as is said to be sometimes the case with bucket loaders. The snow loading boom is interchangeable with the elevator boom on the company's standard loader. The crowding speed has been doubled, making it 8 ft. per min. instead of a trifle over 3 as is used on the loader. Standard feeding propellers are used on the tail shaft of the snow loader in order to clear up the snow for a width of 8 ft. The feeding propellers are followed by a steel plate clean-up scraper built of ¼-in. metal.

In tests recently made the loader in 2 days used 40 gal. of gasoline and loaded 160 8-yd. truckloads. It is said it was idle at least 50 per cent of the time. The first of these machines built was purchased by a contractor in a suburban community to be used in clearing the streets of his city during the winter, the snow boom to be replaced by a bucket boom in the open season for use in his construction work. The machine will, however, be of particular interest to the larger municipalities and street railway companies.

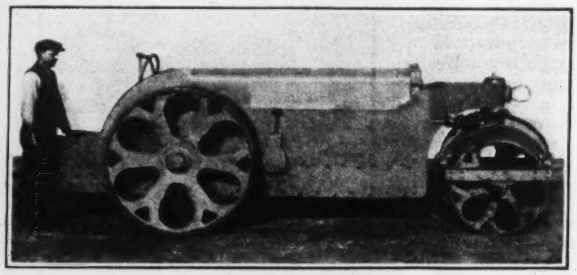
Backfiller Machine Designed for All Light Crane Work

While it is primarily a backfiller, the machine recently designed by the Buckeye Traction Ditcher Co., Findlay, Ohio, can also be used for all light crane work such as handling pipe, batch boxes, forms, stone and steel, rehandling loose material with a clamshell, etc. It has a full circle swing and an adjustable boom which increase its adaptability to many purposes. It utilizes full length crawler traction. The operator faces the work at all times and the machine travels and is easily controlled with the boom facing in any direction.

New Motor Rollers Announced in Sizes of 5 and 7 Tons

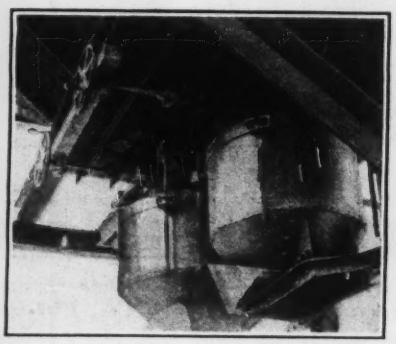
Because of the success that has followed the development of its 10-ton motor roller introduced about five years ago, the Huber Mfg. Co., Marion, Ohio, is this year introducing two smaller sizes of 5 and 7 tons respectively. These smaller motor rollers are powered with a Waukesha four-cylinder engine developing about 30 hp. The roller frame is made of boiler plates rigidly tied together. The front rolls are placed on bearings bushed with bronze. All other journals are hung in a heavy-duty ball or roller bearing. Special attention is called to the spur gear differential which is said to throw the same pulling strains on both drive rollers whether on a straight pull or on a curve.

The roller has two speeds forward and two speeds reverse, travel in both directions being at the same rate. The change from forward to reverse is practically instantaneous and accomplished without shifting gears. A single control lever shifts the heavy friction, one for the forward motion and one for the reverse. It is claimed that there is no kicking of the drive rollers and no danger of killing the engine with this method of control. Both front and rear rolls, as well as the front yoke, are solid castings of nickel iron. A scarifier and a blade grader attachment are available for these new rollers.



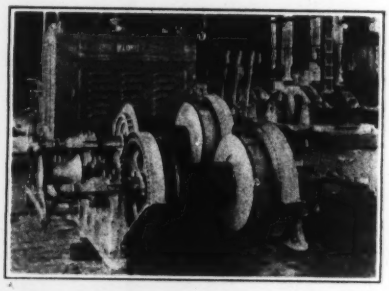
Mechanical Adjustment for Aggregate Batchers

Many batchers have heretofore been adjusted for volume by wing nuts or plain hexagonal nuts which have had to be turned down with a wrench. With four of these on each unit, changing the capacity of the batcher required considerable time. The Heltzel Steel Form & Iron Co., Warren, Ohio, has recently applied a mechanism to its batchers which eliminates the necessity of using wrenches and makes adjustment a very rapid operation. The mechanism consists of a hand wheel which through chains and gears moves screw bars on each corner of the batcher. The four corners are thus raised or lowered at the same time and quite rapidly. A scale is provided which shows capacities measuring 8 to 14 cu.ft. on the sand batcher and 12 to 28 cu.ft. on the stone batcher. The illustration gives a good idea of the details of the mechanism.



New Double-Drum Hoist Is of Two-Speed Type

A hoist has just been designed by the S. Flory Mfg. Co., Bangor, Pa., for special adaptation to slack line excavators and on construction operations where it is often desirable to have a machine capable of handling steel or other heavy material at a comparatively low speed and on other occasions to handle concrete or material elevators at a high speed. Of the two drums, the rear one is equipped with a single set of gearing and a single asbestos cone-type friction, while the front drum is equipped with two sets of gearing and two frictions; the front drum is therefore of the two-speed type. The high speed will handle 2,400 lb. at 400 ft. per min. and the low speed 5,500 lb. at 175 ft. per min. The drum can be changed from high speed to low speed without stopping the motor. As shown in the illustration, the hoist levers are arranged in a battery at the rear. The power unit is a 50-hp. Waukesha engine, although electric motor drive is also available.

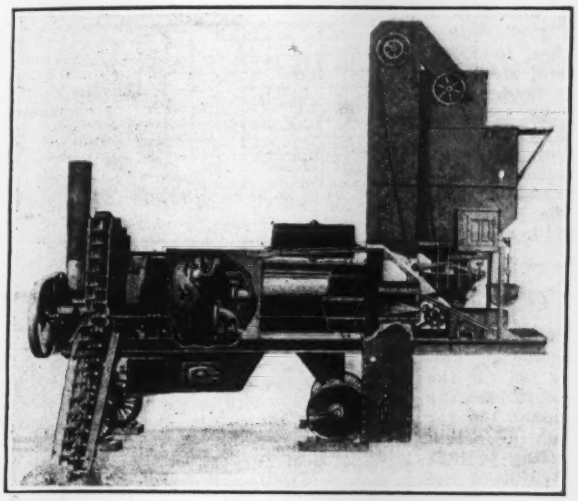


Heat Applied Progressively to Aggregate by New Drier

A new rotary drier for aggregate drying on asphalt plants has been developed by F. D. Cummer & Son Co., Cleveland, Ohio, which is known as the "two-fire drier," since heat is applied from two sources—a coal or oil burning furnace at the feed end and an oil burning combustion chamber at the discharge end. The drier cylinders available range in size from 3 to 7 ft. diameter and from 15 to 50 ft. long. The front or feed end of the cylinder, except that part occupied by the front tire and supporting rollers, is inclosed by a firebrick-lined casing for about one-half of its length; holes cut in these walls are covered on the inside by hoods which allow the heat to enter but prevent material from leaking out, as may be seen in the illustration. The rear end of the cylinder is closed by

a breeching to which an oil burning combustion chamber is fitted.

Below the front-end casing is the coal or oil burning furnace. A fan is attached to a breeching at the front end of the cylinder to supply induced draft to the furnace and to draw the heat through the inlet opening. The wet material is fed through a spout in this front breeching. As this wet material enters the drying cylinder, it is met by a blast of dry hot air from the first hood. As it travels towards the discharge end, it is met by fresh

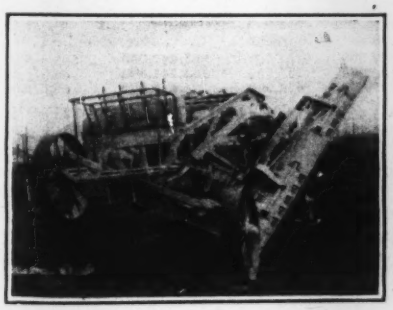


blasts of dry hot air from each of the hoods which are placed at intervals of about 18 in. The drying cylinder is designed so that the material will be warm and almost dry before it passes the last heat inlet, and into the dry heat from the rear oil combustion chamber. By regulating the supply of oil, the material can be discharged at a temperature from 200 to 1,000 deg. F.

This principle of two fires is said to assure dry material and the equipment as a whole is claimed to have a greater capacity and longer life because of the lower temperatures used, the better fuel economy, and closer control of the dried and heated mineral aggregates.

Grading Machine Features Mechanical Control

Elimination of all manual control is one of the outstanding features of the new grading machine manufactured by the Ryan Car Co., Chicago. The illustration shows a 14-ft. machine with the blade in bank-cutting position, showing



the levers which control all operations. As also shown, the machine is of the leaning-wheel type and its blade may be placed in any position for ordinary plowing or dirt moving or for such special work as high bank cutting, berm trimming, snow removal, etc.

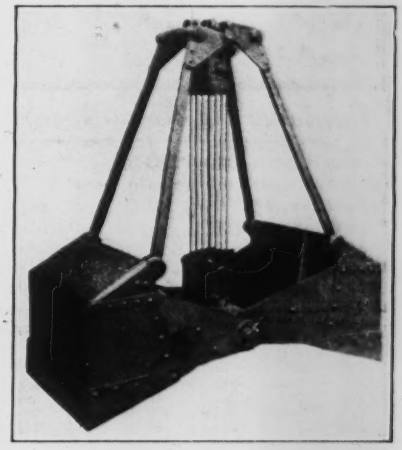
New Buckets Result from Demand for Small Capacities

The increasing use of small gasoline-driven crawler and truck cranes has required the development of suitable small clamshell buckets. The Hayward Co., New York City, has met this demand by producing two new ½-cu.yd. buckets, one of the power wheel type, the other of the rope reeved type. In addition to these two buckets, the company has developed a new dragline, the first one of which was built in a capacity of ¾ cu.yd.

The power wheel clamshell is of comparatively light weight, about 1,700 lb. The rope reeved clamshell is fitted with a nest of seven closing sheaves, made of manganese steel; the bucket is intended for extremely hard digging. It

is also said that all parts are readily accessible. This bucket is built quite narrow in order that it may be used for trenching work, and is provided with manganese digging teeth. It is said that great care has been taken to eliminate possibilities of wear on the closing cable.

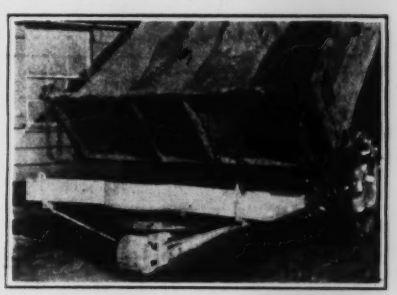
The new drag buckets have several notable features. In the first place, they are claimed to carry their full loads to the end of the boom with practically no spill. In addition to this, they will fill in their own length and are claimed to be very fast dumping. They have the ability to work in limited headroom and the bridle and pulling chains may be so adjusted that the bucket can be operated at any angle on a machine using a boom of any length. They have the open front



feature of the company's other drag buckets in that there is no arch over the front of the bucket.

New Stone and Chip Spreader

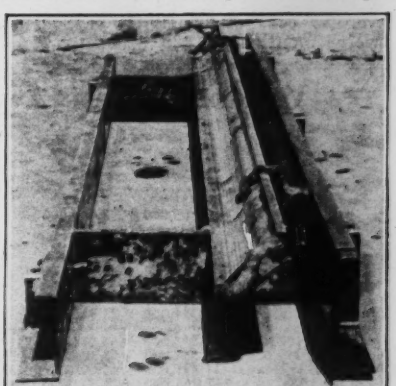
A new type mechanical stone and chip spreader is the most recent product of the Good Roads Co., Inc., Philadelphia. The width of spread is governed



by the speed of travel and varies from 16 to 20 ft. An adjustable slide in the end gate of the truck controls the amount spread per square yard; this may be varied from 5 lb. to 50 lb.

Combined Curb and Gutter Form

The combined curb and gutter form illustrated has recently been developed



by the Metal Forms Corp., Milwaukee, Wis.

Engineering News-Record Statistics of the Construction Industry

Jan. 6, 1927 — *in the United States* — Vol. 98, No. 1

Engineering News-Record CONSTRUCTION COST Index Number (1913 = 100)

MONTHLY
January, 1925 to Date

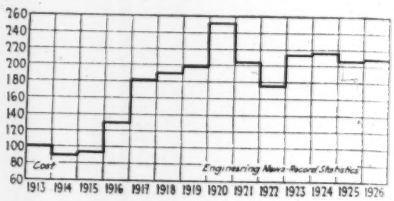
January, 1927	**211.50**
December, 1926	210.80
January, 1926	207.15
Peak, June, 1920	273.80
1913	100.00

1925					
Jan.	210.40	May	207.20	Sept.	202.10
Feb.	209.70	June	204.60	Oct.	205.35
March	210.20	July	204.60	Nov.	205.95
April	209.55	August	204.60	Dec.	205.95

1926					
Jan.	207.15	April	207.05	July	207.80
Feb.	206.55	May	207.30	Aug.	208.30
Mar.	207.65	June	204.80	Sept.	208.30
Oct.	209.80	Nov.	210.80		

ENGINEERING NEWS-RECORD'S Construction Cost Index Number is 2 per cent above January, 1926. The increase is due mainly to labor, which is 3 per cent higher than a year ago. Lumber is cheaper than in 1926; cement about the same; steel appears firmer, with less tendency to cut under. The average rate for common laborers is 55¼c. per hr., against 54c. at this time last year. Thus, general construction cost is 0.3 per cent above December, 1926, 23 per cent under the peak and 111 per cent above 1913.

YEARLY
1913 to 1926



Engineering News-Record CONSTRUCTION VOLUME Index Number (1913 = 100)

MONTHLY
January, 1925 to December, 1926

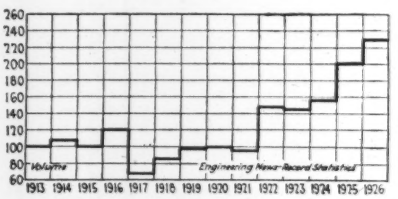
December, 1926	**188**
November, 1926	211
December, 1925	206
Peak, August, 1925	266
1913	100

1925					
January	141	May	209	September	262
February	145	June	214	October	233
March	161	July	178	November	194
April	211	August	266	December	206

1926					
Jan.	198	April	233	July	248
Feb.	187	May	254	Aug.	252
Mar.	240	June	246	Sept.	227
October	244				

ENGINEERING NEWS-RECORD'S Construction Volume Index Number is 188 for the month of December and 228 for the whole of 1926, as against 100 for 1913. This means that the actual volume of contract letting in 1926 (not the mere money-value of the contracts let that year) is 128 per cent above the volume for 1913. The monthly volume number, 188 for December, 1926, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

YEARLY
1913 to 1926



Unprecedented Volume of Construction Contract Letting in 1926

Gain More Than 11 Per Cent Over 1925, The Previous Record Year

THE year 1926 established a new high record in the construction industry, both as to value of contracts let and actual volume of work accomplished, according to *Engineering News-Record* statistics.

Construction has gained steadily, year by year, since 1921. The record volume, as measured by materials used, is accentuated by the fact that the average cost of construction for the twelve months of 1926 was only 2 per cent above the average cost for the last five years.

In the accompanying table only heavy construction or engineering work is included and in arriving at these figures, the following minimum was adopted in each case: water-works and excavations, drainage, irrigation, river, levee and harbor work, $15,000; other public work, $25,000; industrial buildings, $40,000; commercial, educational, religious and other buildings, $150,000.

Based on the minimum values just mentioned, total contracts let for the entire United States, from 1913 to 1926, inclusive, are as follows:

1913..	$601,405,000	1920..	$1,523,076,000
1914..	582,884,000	1921..	1,193,514,000
1915..	584,875,000	1922..	1,556,592,000
1916..	933,335,000	1923..	1,904,040,000
1917..	739,102,000	1924..	1,999,290,000
1918..	992,744,000	1925..	2,559,443,000
1919..	1,175,888,000	1926..	2,851,786,000

Every section of the country showed a gain over 1925, except the Middle

(*Continued on p. 43*)

Value of Contracts Awarded in the U. S. and Canada During December, 1926—Totals for 1926 and 1925

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Canada	Total for U. S., 1926	Total for U. S., 1925
Waterworks	.....	$881,000	$396,000	$3,153,000	$1,060,000	$407,000	$5,897,000	$181,000	**$61,647,000**	$69,368,000
Sewers	$431,000	814,000	504,000	2,611,000	743,000	2,189,000	7,292,000	233,000	**103,741,000**	84,577,000
Bridges	83,000	2,446,000	591,000	503,000	1,833,000	104,000	5,559,000	400,000	**83,383,000**	69,876,000
Excavation, drainage, irrigation	.....	86,000	67,000	78,000	239,000	15,000	485,000	.....	**27,810,000**	40,080,000
Streets and roads	2,132,000	2,637,000	6,389,000	1,854,000	6,549,000	4,508,000	24,069,000	238,000	**483,898,000**	421,039,000
Industrial building	4,110,000	4,560,000	1,085,000	5,704,000	3,640,000	1,250,000	20,349,000	225,000	**311,605,000**	227,616,000
Commercial building	12,523,000	28,005,000	4,439,000	42,674,000	11,341,000	25,169,000	124,151,000	2,100,000	**1,482,946,000**	1,374,100,000
Federal Government	83,000	286,000	537,000	77,000	156,000	2,333,000	3,472,000	.....	**50,262,000**	34,272,000
Unclassified	385,000	25,336,000	5,564,000	1,050,000	5,297,000	692,000	38,329,000	270,000	**244,494,000**	238,515,000
December, 1926	$1,593,000	$65,051,000	$19,572,000	$57,709,000	$30,858,000	$36,667,000	$229,603,000	$3,647,000	**$2,851,786,000**	$2,559,443,000
November, 1926	24,031,000	53,308,000	26,659,000	56,660,000	24,303,000	21,860,000	206,821,000	40,313,000	.....	.....
December, 1925	11,699,000	101,006,000	23,811,000	51,932,000	25,602,000	32,869,000	246,919,000	1,232,000	.....	.....
Total for 1926	**247,095,000**	**856,327,000**	**288,891,000**	**724,428,000**	**412,401,000**	**322,644,000**	**2,851,786,000**	**144,347,000**	.....	.....
Total for 1925	199,370,000	935,216,000	247,966,000	474,212,000	407,558,000	295,121,000	2,559,443,000	83,067,000	.....	.....

Unprecedented Volume of Construction, Etc.

(*Concluded from p.* 42)

Atlantic states, which declined 8 per cent in total money value. The Mid-West netted the heaviest gain for 1926.

All classes of construction registered increases in money value of lettings except water-works and jobs classified as excavations. The drop in the former amounted to 11 per cent while that of the latter was even more pronounced. All classes of engineering construction, for the entire country, showed a gain of 11 per cent over the previous record year 1925.

New engineering work proposed during December, 1926 reached a total of $586,724,000, a gain of 25 per cent over the same month in 1925.

Total proposed for the year 1926 amounted to $5,556,270,000 as against $4,833,614,000 for the whole of 1925.

Since projects definitely reported as proposed are rarely abandoned, the volume at hand will undoubtedly sustain contract letting throughout the first quarter at somewhere near the 1926 rate.

Bulletin Board

1. Four pages of government road statistics assembled by "Engineering News-Record" will be found on pp. 16 to 19.

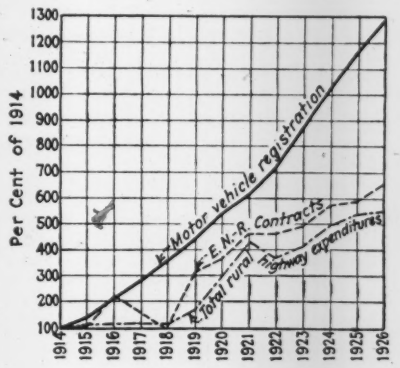
2. ENGINEERING NEWS-RECORD UNIT PRICES *is the name of a new section, to be found following Construction News. Just keep turning to the right.*

3. Next week's issue (Jan. 13) will contain Engineering News-Record's statistics of the construction industry for 1926. There will also be a forecast for 1927.

Relation of E. N.-R. Road Statistics To Government Statistics

ENGINEERING NEWS-RECORD reports individual road contracts of $25,000 and more, and groups of contracts totaling that amount. Statistics compiled from these reports have been compared with such figures as are in the possession of the U. S. Bureau of Public Roads, and found to be very representative of these total figures.

The chart shows the value of road contracts reported by *Engineering News-Record* and the total rural highway expenditures reduced to percentages of 1914. The two curves follow the same direction, except for the war years, 1917 and 1918. This may be due to the fact that large contracts fell off appreciably or that expenditures by incorporated towns (not included in Bureau of Road statistics) decreased to a greater extent than the expenditures for rural highway purposes. The latter years particularly show a very close correspondence. If 1920 had been used for a base, the two curves would almost coincide. Contracts of $25,000 or over (including expenditures by incorporated cities) form about 42 per cent of the total expenditures for rural highways.



Another check-up on *Engineering News-Record* statistics is the proportion of money spent on roads to that spent on bridges. From 1915 to 1918 the Bureau of Public Roads compiled statistics on the amount of money spent on bridges and on roads. For these four years, the percentage of bridges to roads was 16 per cent. According to *News-Record* statistics, bridges form 17 per cent of the road contracts. If the private bridge contracts reported by *News-Record* are disregarded, the percentage becomes 15 per cent.

Few Labor Troubles Other Than Five-Day Week Demand in Prospect for 1927

Current Wage Schedules Compared With Those of Jan. 1, 1926, Show Many Gains

STRIKES, wage controversies, or other labor disturbances, are present or in prospect, in only six out of the twenty-one great industrial districts covered regularly by *Engineering News-Record.*

In San Francisco, the carpenters and employers are working out a settlement of the nine-months old fight over open shop conditions in that trade. The Impartial Wage Board has also agreed upon wage advances in the building trades, bringing San Francisco more in line with the other large cities.

Pittsburgh faces a serious tie-up of an extensive construction program, in possibilities of strikes among building trades mechanics, arising out of demands for higher wage rates and the five-day week. Thus far, the bridge and structural iron workers have asked for the five-day week and an advance from the present rate of $1.50 per hr. to $1.75.

The situation in New York is not one of friction between the mechanics and employers but centers in the investigation of the local union by the International Electrical Workers' organization. Bribery and conspiracy are charged against local members by the International body in the injunction suit now before the Supreme Court.

Chicago painters have signed an agreement with the Decorating and Painting Contractors Association to observe closed-shop rules during the next two years. Aside from this leaning away from the open shop, on the part of Chicago employers, no disturbances of the labor market are indicated for the coming year.

Cincinnati bricklayers demand the five-day week and an advance from the present rate of $1.50 to $1.75 per hr. The present agreement, however, does not expire until May 1, 1927.

Cleveland faces a renewal of sixteen wage agreements expiring March 1, 1927. It is expected that most of the trades will demand increases.

Current Building Trades Wage Rates per Hour Compared With Those In Effect a Year Ago

Cities	Bricklayers		Carpenters		Hoisting Engineers		Hod Carriers		Structural Ironworkers	
	1927	1926	1927	1926	1927	1926	1927	1926	1927	1926
Atlanta	$1.40	$1.12½	$0.70	$0.70	$0.70	$0.70	$0.50	$0.50	$0.75	$0.75
Baltimore	1.62½@1.75	1.50@1.75	1.00@1.10	1.00@1.10	1.00@1.12½	1.00@1.12½	1.00	1.00	1.12½	1.12½
Birmingham	1.00@1.50	1.00@1.50	.40@1.05	.35@87½	.75@1.00	.75@1.25	.50@ .75	.50@ .75	.75@1.75	.75@1.75
Boston	1.40	1.25	1.25	1.10	1.25	1.00@1.30	.79	.75	1.25	1.10@1.25
Cincinnati	1.50	1.50	1.31½	1.25	1.31½	1.25	.95	.92½	1.31½	1.25
Chicago	1.62½	1.50	1.10@1.50	1.37½	1.00@1.50	1.37½	.90	.87½	1.50	1.37½
Cleveland	1.50	1.50	1.25	1.25	1.30	1.30	.87½@1.10	.87½	1.50	1.50
Dallas	1.62½	1.62½	1.12½	1.12½	1.00	1.00	.40 @ .75	.40 @ .75	1.00	1.00
Denver	1.62½	1.62½	1.25	1.12½	1.12½@1.18¾	1.12½@1.18¾	.81¼@ .87½	.81¼@ .87½	1.15¾	1.15¾
Detroit	1.50	1.50	.90@1.15	.70@1.00	.85@1.00	.85@1.00	.90	.90	1.12½	1.12½
Kansas City, Mo.	1.50	1.37½	1.37½	1.12½	1.25	1.12½@1.25	.90	.90	1.25	1.25
Los Angeles	1.37½	1.25	1.00	1.00	1.00	1.00	.87½	.87½	1.00	1.00
Minneapolis	1.25	1.12½@1.25	.87½@.95	.87½@.90	.87½	.87½	.75	.71½	1.00	.87½
Montreal	1.00	.90	.75	.65	.60	.56¼	.40	.25@.30	.75	.80
New Orleans	1.50	1.25	.90	.90	1.00	1.00	.75	.65	1.25	1.25
New York	1.75	1.50	1.50	1.31¼	1.75	1.50	1.12½	1.00	1.75	1.50
Philadelphia	1.50@1.62½	1.62½	1.12½@1.25	1.12½	1.02½	1.02½	1.12½	1.12½	1.12½@1.25	1.12½@1.25
Pittsburgh	1.62½	1.62½	1.50	1.37½	1.37½@1.50	1.37½@1.43¾	1.12½	1.09¾	1.50	1.43¾
St. Louis	1.75	1.75	1.50	1.50	1.50 @1.65	1.50@1.65	1.15@1.25	1.15@1.25	1.50	1.50
San Francisco	1.37½	1.25	1.12½	1.00	1.00@1.06¼	1.00	.87½	.81¼	1.37½	1.12½
Seattle	1.37½	1.37½	1.12½	1.12½	1.00@1.12½	1.00@1.12½	1.00	1.00	1.12½	1.12½

Steadiness of Prices Feature of 1926-27 Building Materials Market

Compared With January of Last Year, Such Changes as Did Occur Were Largely in Downward Direction

FEWER price changes occurred during the year just closed than in any year since 1922, so far as construction materials are concerned.

Materials showing the most pronounced steadiness in prices, were: Steel rails, standard; wrought-steel pipe; railway ties; sewer pipe, 27-in. and larger; road oils; curbing; flagging; wood paving blocks; portland cement; reinforcing bars; hollow building tile; structural shapes; rivets; nails; ship spikes; plate and window glass; red and white lead; pine piles; wire rope; and explosives.

In comparing current quotations on the principal materials, with those in effect at this time last year, it is found that the declines more than double the advances, in total number.

Higher prices prevail now than in January, 1926, for railway track supplies; sand; gravel; crushed stone; reinforcing material for road construction; roofing materials; and certain of the water treatment chemicals.

Prices are below a year ago, in light and re-rolled rails; clay drain tile, small sizes; sewer pipe, 3 to 24-in.; asphalt; paving stone; lime; steel sheetpiling; and manila rope. Pig-iron and scrap are $2@$3 per ton under the January, 1926 levels; cast-iron pipe is about $3 per ton lower. Other average declines are 10c. per 100 lb. in steel sheets; 14c. per gal. in linseed oil; and about $1 per M. ft. in pine and fir timbers. An average for the nation would probably show one and two-inch boards to be about $1 per M ft. below a year ago.

From present indications, most of the basic materials will hold at prices now in effect, until spring.

Marked firmness, with rising tendencies, is noted in sand, gravel, manila rope, paving stone, asphalt, sewer pipe in sizes 10 to 24-in., and hollow tile. The last mentioned material will probably show a seasonal rise of 8 per cent or more, after March 1, 1927.

Despite heavy importations of foreign building materials during 1926, prices of cement, steel, pipe, glass, lumber and brick show no weakness. Cement is down 10c. per bbl. from last month's levels in four Mid-Western cities.

Building Industry Stabilized in Rochester

Community Conference Board In That City Reports Complete Success—Seasonal Peaks Eliminated

Lengthening of the building season, increased purchasing power of the average building trades mechanic, reduction in number of labor disturbances and other benefits to all connected with the construction industry in Rochester, N. Y., are claimed to have been accomplished by the Community Conference Board of that city, in a report released by Henry Sayer, Executive Secretary of the Industrial Survey Commission.

Mr. Sayer's statement follows:

"An entirely new idea—stabilization of the building industry, so that mechanics and contractors are employed practically the entire year has been worked out and is said to be a complete success in Rochester, N. Y., where the thought originated.

"This was the information furnished the legislative industrial survey commission by George Eastman, philanthropist and head of the Eastman Kodak Co., chairman of the board in that city which has worked out the plan. It is endorsed alike not only by the organizations of business men and contractors, but by the labor unions as well, according to testimony presented to the commission.

"As a result of the work of the board, known as the community conference board, labor troubles in the building trades have been practically eliminated, the employees are receiving a greater amount of money each year, as well as a higher rate of wage, and seasonal peaks in the industry have been practically wiped out.

"The conference board is composed of representatives of all interests in the building industry; including the city government, board of education, chamber of commerce, real estate board, builders exchange and the architects' society of that city.

"Essentially the organization is a fact finding agency, which is gathering continuous data on conditions in the industry and then suggesting the proper course to be followed for a given period.

"Each month a survey of employment is made, based on reports from a large number of contractors. If it is found that activity is slowing up in any particular craft, efforts are made to stimulate employment in that line. The number of building permits issued each month is scanned, and the structures classified as to type. Then a survey is made of the basic materials used in construction, such as sand, gravel, crushed stone and cement. This is the chief index in the building situation for any given period.

"The information thus gathered is broadcast through diversified channels: the newspapers, letters, personal talks, radio and articles in the magazine of the chamber of commerce being the main avenues of expression. Through these forms of publicity, the public is kept informed of the situation and urged to co-operate by having as much winter building as possible, the contractors are kept informed of conditions that they will have to face, and the craftsmen are always available for work, all things being equal.

"According to Eastman, the efforts of the community board, have brought about these results. The average hourly rate of building trade workers in Rochester is $1.04 as compared with 94 cents in 20 other cities of the same population class, the actual earnings of high grade building mechanics in 1925 averaged $2,500 for the year, or 94 per cent of the theoretical figure for the year, the purchasing power of the average tradesman is 42 per cent higher than in 1914, because wages have increased 135 per cent and living costs have gone up but 66 per cent, the building season has lengthened by at least 20 per cent, there has been but one minor and brief labor disturbance in the last five years in the industry.

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Jan. 5, 1927	$14,187,000	$27,212,000	$41,399,000
Dec. 30, 1926	12,900,000	18,719,000	31,619,000
Jan. 7, 1926	26,246,000	33,455,000	59,701,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
Yearly Totals			
1926	1,088,155,000	1,763,631,000	2,851,786,000
1925	1,037,252,000	1,522,191,000	2,559,443,000

E. N.-R. Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	Jan. 6	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	$24.19	$24.05
Northern Basic	20.89	24.27
No. 2 Southern Ohio (silicon 1.75@2.25)	21.39	24.27
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	26.37	28.37
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	20.00	23.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	23.76	24.16
Virginia No. 2 (silicon 2.25@2.75)	28.19	29.17
Basic	21.26	23.16
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	21.00	23.00
No. 2 Foundry Southern (silicon 2.25@2.75)	24.55	26.55
PITTSBURGH, including freight charge ($1.76) from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	20.76	22.27
Basic	20.26	22.27
Bessemer	21.26	22.27

SCRAP—The prices following are f.o.b. per net ton paid by dealers:

	New York*	Chicago	Birmingham
No. 1 railroad wrought	*$13.00@$14.00*	*$12.00@$12.50*	$12.00@$13.00
Stove plate	*9.25@ 11.50*	*13.50@ 14.00*	14.00@ 14.50
No. 1 machinery cast	16.00@ 17.00	16.00@ 16.50	17.00@ 17.50
Machine shop turnings	9.25@ 9.75	6.00@ 6.50	8.00@ 8.50
Cast borings	**9.25@ 13.50**	8.75@ 9.25	8.00@ 9.00
Railroad malleable	*15.50@* 16.00	14.25@ 14.75	16.00@ 17.00
Re-rolling rails	12.50@ 13.00	*14.25@ 14.75*	15.00@ 16.00
Re-laying rails	23.00@ 24.00		21.00@ 22.00
Heavy melting steel	*9.25@ 12.75*	11.50@ 12.00	13.00@ 14.00

*Gross ton.

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh				
	Jan. 6	One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	
Standard openhearth rails	43.00	43.00	43.00	43.00	$51.00
Light rails, 8 to 10 lb.			34@36	1.80@1.90*	2.05-2.15*
Light rails, 12 to 14 lb.		36@38	34@36	1.80@1.90*	1.88-1.98*
Light rails, 25 to 45 lb.	36.00	36@38	34@36	1.80@1.90*	1.84-1.94*
Re-rolled rails	*27@30*	33@35	30.00	34@36	18@21

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, white oak, plain	$1.45	$1.83
Chicago, empty cell creosoted	1.85	2.45
Chicago, zinc treated	1.65	2.15
San Francisco, green Douglas fir	.84	1.14
San Francisco, empty cell creosoted, Douglas fir	1.70	2.25
St. Louis, white oak, plain	1.20	1.45
St. Louis, zinc treated	1.60	1.85
St. Louis, red oak, plain	1.10	1.35
St. Louis, sap pine-cypress	.95	1.20
Birmingham, white oak	1.25	1.45

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh mill for carload lots, together with the warehouse prices at the places named:

	Pittsburgh					
	Jan. 6	One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	$2.80@$2.90	$2.80	$3.55	$3.65	$4.35	$3.00
Track bolts	3.90@4.25	3.90@ 4.15	4.55	4.60	5.85	3.90
Standard section angle bars	2.85	2.75	3.40	3.75	3.60	4.15

Pipe

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	12

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

STEEL PIPE—From warehouses at the places named the following discounts hold for welded steel pipe:

	Black			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	53%	54%	62%	49%
2½ to 6 in. lap welded	48%	51%	59%	46%

	Galvanized			
	New York	Chicago	Birmingham	St. Louis
1 to 3 in. butt welded	39%	41%	50½%	36%
2½ to 6 in. lap welded	35%	38%	47½%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4% less 5%. Cast iron, standard sizes, 30—5% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham	Burlington, N. J.	New York Jan. 6	New York One Year Ago
4 in.	*$42.00*	*$50.00*	*$52.60*	$55.60@56.60
6 in. and over	*38.00*	*46.00*	*48.60*	51.60@52.60
	Pittsburgh	**Chicago**	**St. Louis**	**San Francisco**
4 in.	*$50.60*	*$50.20*	*$48.60*	*$52.00*
6 in. and over	*46.60*	*46.20*	*44.60*	*48.00*

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York Jan. 6	New York One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	$45.00	$48.00	$40.00	$45.00		$73.00
4	55.00	60.00	40.00	56.00	$76.50	110.00
5				80.00	97.75	118.00
6	90.00	90.00	70.00	100.00	127.50	150.00
8	160.00	160.00	170.00	165.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3		*$0.08*	$0.10		*$0.088*	$0.12	
4		*.08*	.10	$0.10	*.088*	.15	$0.15
5		*.11*	.135		*.121*	.18	.18
6	$0.24	*.11*	.21	.14	*.121*	.21	.21
8	.43	*.18*	.315	.225	*.198*	.30	.325
10	.50	**.252**	.45	.315	.315	.42	.476
12	.65	**.324**	.54	.405†	.405	.56	.612
15	1.08†	**.432**	.75	.675†	.54	.92	1.02
18	1.58†	**.60**	.90	.945†	**1.00**	1.32	1.53
20	1.89†	**.72**	1.20		**1.20**		
21		**.84**	1.25†	1.26†	1.40		
22	2.52†	**.96**	1.35		**1.60**		1.564
24	2.84†	**1.08**	2.665	1.62†	**1.80**	2.16	2.04
27	4.65†	2.405	2.952	2.45†	2.75	3.00	3.34
30	5.16†	2.664	3.96	3.00†	3.75	3.60	4.06
33	6.98†	3.60	4.51	3.55†	4.50		4.99
36	8.00†	4.10	5.06	3.95†	5.00		5.42

	3	5	8	12	24	36
Boston	$0.12	$0.18	*$0.26*	*$0.50*	*$1.90†*	*$5.20†*
Minneapolis			.25	.45	1.50	4.56
Denver	.135*	.18*	.27	.47	1.70	
Seattle	.14		.35	.63	2.52	
Los Angeles	.1675	.186	.2825	.504	1.74	
New Orleans	.205	.40	2.27	3.50		
Cincinnati	.105	.1575	.245	.4725	1.575	4.715
Atlanta	.10*	.15*	.25	.425	1.625	
Montreal		.50	.70	1.35	4.50	
Detroit	.111	.1665	.259	.4995	1.665†	3.7925†
Baltimore	.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.	.15	.21	.29	.52†	1.90†	3.80†
Philadelphia	.11	.16	.26	.42	1.50	3.70

*4-in., 6-in., 9-in., respectively. †Double Strength.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars, 8,000 gal. minimum f.o.b. place named:

	Jan. 6	One Year Ago
New York, 45% asphalt (at terminal)	$0.065 @ $0.075	$0.065 @ $0.07
New York, 65% asphalt (at terminal)	.0675@ .0725	.0675@ .0725
New York, binder (at terminal)	.07 @ .075	.07 @ .075
New York, flux (at terminal)	.07 @ .075	.07 @ .075
New York, liquid asphalt (at terminal)	.07 @ .075	.07 @ .075
St. Louis, 40@50% asphalt	.0503	.0525
St. Louis, 50@60% asphalt	.0523	.055
Birmingham, 55% asphalt	.0475	.0475
Dallas, 45% asphalt	.0495	.0495
Dallas, 50% asphalt	.0455	.0455
Dallas, binder	.061	.061
San Francisco, binder, per ton	12.00*	12.00*

* F.o.b. Oleum, Cal. Freight to San Francisco, 80c. per ton.

E. N.-R. Prices of Construction Materials

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Texas*)	**$24.50**	
Boston (*Mexican*)	23.00	18.50
Chicago (*Texas*)	**28.00**	**23.00**
San Francisco, *f.o.b. refinery*, Oleum, Cal.	18.00	12.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	19.50	13.50
Denver (*California*)	24.00	.....
Minneapolis, *f.o.b. Twin Cities (Standard)*	27.60	21.60
St. Louis (*Mexican*)	27.00	24.00
Baltimore (*Standard Oil*) (*f.o.b. refinery*)	22.50	18.50
Montreal (*Imperial*)	27.00	22.50
Atlanta (*Mexican*)	23.40	19.40
Detroit (*Mexican*)	22.25	18.50
Cincinnati (*Kentucky Rock*)	.....	11.65
Maurer, N. J. (*Bermudez*)	30.00	.....
Maurer, N. J. (*Trinidad*)	23.00	.....
Philadelphia (*Mexican*)	20.00	18.00
Kansas City, Mo. (*Texas*)	**28.30**	23.30
Los Angeles ("*D*" *grade, California*)	*18.00	*12.00
Birmingham (*Mexican*)	27.00	21.00
New Orleans (*Mexican*)	20.00	17.00

* F.o.b. El Segundo Refinery. Drums used in New York.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade I)	5-in. granite, 30 blocks per sq.yd.	$142.40 per M.
San Francisco	Basalt block 4x7x8	70.00 per M.
Chicago	about 5x8x5 dressed	3.60 per sq.yd
	about 5x8x5 common	3.25 per sq.yd.
Boston	5-in. Granite	135.00 per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	2.75 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	Granite, 4x8x4	1.65 per sq.yd.
Kansas City	Granite	**4.00** per sq.yd.
Philadelphia	Granite	3.90@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.24 per sq.ft.
	Manhattan, 4 ft. wide	.24 per sq.ft.
	Queens, 5 ft. wide	.26 per sq.ft.
	6x24-in. cross-walk	1.30 per lin.ft.

CURBING—*New York*: Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 88c.; *St. Louis*: Class "A" straight, delivered, 5x18 in., 85c. per lin.ft.; roundings, $1.35. *Birmingham*: Limestone, 5x18-in., $1.05 per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd.
New York	3	16	$2.40
New York	3½	16	2.70
Boston	3½	18	2.40
Chicago	4	16	2.25
Chicago	3½	16	2.10
St. Louis	3½	16	2.40
St. Louis	4	16	2.75
Seattle	4	16	Off market
Minneapolis	3½	16	2.40
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Detroit	4	16	.....
Cincinnati	3½	16	2.35
Kansas City	4	16	2.50
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor, f.o.b., per cu.yd. is as follows:

	Gravel 1½ In.		Gravel ¾ In.		Sand	
	Jan. 6	One Year Ago	Jan. 6	One Year Ago	Jan. 6	One Year Ago
New York (*alongside dock*)	$1.75	$1.75	$1.75	$1.75	$1.00	$1.00
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	1.85	1.65	1.85	1.65	1.65	1.50
St. Louis	1.45	1.45	1.45	1.45	.93‡	1.08
Seattle	1.25	1.50	1.25	1.50	1.25	1.50
Dallas	2.38*	2.38	2.38*	2.38	2.00*	2.00
Minneapolis	1.65‡	1.65‡	1.65‡	1.65‡	1.25*	1.25
Cincinnati	1.30†	1.40†	1.30†	1.40†	1.05†	1.35†
San Francisco	1.80	2.15	1.80	2.15	1.40	1.50
Boston (*on trucks at dock*)	**1.75†**	1.50†	**1.75†**	1.50†	**1.25†**	1.00†
New Orleans	2.10†*	2.60	3.00†*	2.60	1.80†	1.75
Los Angeles	1.95†	.85‡†	1.95†	.85‡†	1.70†	.50‡†
Atlanta	1.90†	1.90†	1.90†	1.90†	1.60†	1.50†
Detroit	**1.70**	2.02	**1.60**	2.02	**1.35**	1.62
Baltimore	1.40	1.40	1.60	1.60	.70‡	.70††
Montreal	**1.50†**	1.25†	**1.50†**	1.25†	1.25†	1.25†
Birmingham	2.00*	2.00	2.00*	2.00	1.50	1.50
Philadelphia	**2.25***	2.10	**2.25***	2.10	**1.65**	1.50
Kansas City, Mo.	.....	.....	.....	.....	.66‡†	.66‡†

New York—Grits, $1.75 per cu.yd.; ready mixed $1.85

*Delivered. †Per ton. ‡At pit.

CRUSHED STONE—Price for cargo or carload lots, per cu.yd. f.o.b. city, is as follows:

	1½ In.		¾ In.	
	Jan. 6	One Year Ago	Jan. 6	One Year Ago
New York	$1.84	$1.75	$1.94	$1.85
Chicago	1.70	1.75	1.87½	1.87½
St. Louis	1.83*	1.93*	1.93*	1.93*
Dallas	2.40†	2.40	2.83†	2.83
San Francisco	1.70	2.15	1.70	2.15
Boston (*on trucks at dock*)	2.10*	1.60*	2.10*†	1.60*
Minneapolis	1.75	1.75	1.75	1.75
Kansas City	2.00†	1.50	2.00†	1.50
Denver	2.50†	2.50	2.50†	2.50
Seattle	3.00†	3.00	3.00†	3.00
Atlanta	2.50*†	2.10*	2.50*†	2.10*
Cincinnati	1.65*	1.90*	1.65*	1.90*
Los Angeles	2.10*†	1.00*	2.10*†	1.00*
Detroit	2.60*†	2.00*	2.60*†	2.00*
Baltimore	2.50†	2.50	2.55†	2.55
Montreal	1.80*	1.80*	2.00*†	1.50
Philadelphia	**2.25†**	2.10	**2.25†**	2.10
Pittsburgh	2.75†	2.85	2.75†	2.85
Cleveland	2.70*†	3.25*	2.70*†	3.25*
Birmingham	2.00†	2.00	2.00	2.00

* Per ton. † Delivered.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plant

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.30	$1.40	$2.00	$1.30
Buffalo District	1.25	1.35	2.25	1.25
Birmingham, Ala	.90	1.25	2.05	.80
Cleveland, Ohio	1.70*	1.70*	.....	1.40*
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25

*Includes freight charge.

LIME—Warehouse prices:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
New York	$18.20	$11.00	$3.50*	$2.10@3.00*
Chicago	20.00	18.00	.....	1.50†
St. Louis	23.50	19.50	.....	2.03*
Boston	*18.35*	*11.50*	3.55*	*2.50@3.00*
Dallas	19.00	.....	.....	1.82†
Cincinnati	16.80	11.90	.....	11.40‡
San Francisco	25.50	22.00	.....	1.60†
Minneapolis	25.50	21.00	.....	1.70†
Denver	24.00	.....	.....	2.70*
Detroit	15.25	11.25	.....	11.75‡
Seattle, *paper sacks*	24.00	.....	2.80†	.....
Los Angeles	25.00	15.00	3.50*	19.00‡
Baltimore	24.25	17.85	2.55†	.....
Montreal	.....	21.00	.....	10.00‡
Atlanta	22.00	13.00	.....	1.40†
New Orleans	24.00	15.00	2.60†	2.25*
Philadelphia	23.00	16.00	.....	.....
Kansas City	18.50	17.50	2.45†	2.10*
Birmingham	22.50	16.00	2.40†	1.85†

* Per 280-lb. bbl. (net). † Per 180-lb. (net). ‡ Per ton.

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, exclusive of bags:

	Jan. 6	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	**1.45**	1.35
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	**2.75**	2.65
St. Louis (Carney)	2.35	2.50
Birmingham (Magnolia) pozzolan cement	2.40	2.40

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Jan. 6	One Month Ago	One Year Ago
New York, del. by truck	$2.50@$2.60	$2.50@$2.60	$2.50@$2.70
New York, alongside dock to dealers	2.15	2.15	2.15
Jersey City	2.33	2.33	2.33
Boston	2.35	2.25	2.40
Chicago	2.10	2.10	2.10
Pittsburgh	2.09	2.09	2.09
Cleveland	2.29	2.29	2.29
Detroit	2.15	2.15	2.15
Indianapolis	2.29	2.29	2.29
Milwaukee	2.25	2.25	2.25
Duluth	2.09	2.09	2.09
Peoria	2.27	2.27	2.27
Cedar Rapids	*2.24*	2.34	2.34
Davenport	2.29	2.29	2.29
St. Louis	2.20	2.20	2.20
San Francisco	2.31	2.31	2.31
New Orleans	2.40	2.40	2.40
Minneapolis	*2.22*	2.32	2.32
Denver	2.85	2.85	2.84
Seattle	2.65	2.65	2.65
Dallas	2.05	2.05	2.05
Atlanta	2.35	2.35	2.30
Cincinnati	2.37	2.37	2.37
Los Angeles	2.50	2.50	2.52
Baltimore	2.50	2.50	2.50
Birmingham	2.40	2.40	2.40
Kansas City, Mo	2.05	2.35	2.40
Montreal	1.15	1.15	1.80
Philadelphia	2.50	2.50	2.60
St. Paul	*2.22*	2.32	2.32
Toledo	2.20	2.20	2.20

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	$1.85	Hudson, N. Y.	$1.95
Universal, Pa	1.85	Leeds, Ala	1.95
Steelton, Minn	1.90	Hannibal, Mo	1.95
Fordwick, Va	2.05	Lehigh Valley District	1.85
Mitchell, Ind	1.95	Wyandotte, Mich	1.90
Iola, Kan	1.85	Alpena, Mich	1.75
Mason City, Ia	*1.80*	Richard City, Tenn	2.05
La Salle, Ill	1.95	Kingsport, Tenn	2.05

E. N.-R. Prices of Construction Materials

TRIANGLE MESH—Price per 100 sq.ft. in carload lots at mills; from warehouse in less-than-carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.06	$1.13	$1.22
049	28	1.26	1.29	1.76	1.35	1.38	1.55
068	35	1.54	1.58	2.16	1.66	1.67	1.91
093	45	1.98	2.03	2.77	2.13	2.00	2.46
126	57	2.45	2.51	3.45	2.63	2.55	3.03
153	68	2.92	2.99	4.11	3.14	3.15	.....
180	78	3.35	3.43	5.70	3.60	3.47	.....
245	103	4.43	4.53	6.21	4.75	4.58	.....
287	119	5.12	5.24	7.19	5.50	5.26	6.35
336	138	5.93	6.07	8.35	6.37	6.11	.....
395	160	6.88	7.04	9.65	7.38	7.12	.....
		PAVING					
036P	17	$0.76	$0.77	$1.06	$0.81	$0.76	.....
053P	24	1.07	1.09	1.50	1.14	1.07	.....
072P	31	1.35	1.38	1.90	1.45	1.39	.....
097P	40	1.74	1.78	2.45	1.87	1.90	.....
049R	24	1.07	1.09	.....	1.14	1.02	.....
067R	31	1.35	1.38	.....	1.45	1.39	.....
089R	40	1.74	1.78	.....	1.87	1.90	.....

In rolls, 48-,-52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in less-than-carload lots per 100 yd. for painted:

Weight in pounds	New York	Birmingham	Chicago	St. Louis	San Francisco	Dallas
2.2	$17.50	*$19.50*	*$17.50*	**$22.50**	*$19.00*	$24.00
2.5	18.50	*21.50*	*18.50*	**24.50**	*21.00*	26.00
3.0	21.00	*24.50*	*21.00*	**27.00**	*24.00*	29.00
3.4	22.50	*27.50*	*22.50*	**29.00**	*26.00*	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb., in carload lots, f.o.b., except at New York and St. Louis warehouses:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$2.00	$2.25	$3.24	$2.30@$2.50	$3.15	$2.75	$2.95
⅝	2.10	2.35	3.34	2.40@ 2.60	3.25	2.85	3.05
¾	2.20	2.45	3.44	2.50@ 2.70	3.35	2.95	3.15
⅞	2.40	2.65	3.64	2.70@ 2.90	3.55	3.10	3.35
1	3.00	3.25	4.24	3.30@ 3.50	4.15	3.75	3.95

For standard classification of extras for size and cutting of steel bars, see bar card of July, 15, 1923.

ROLLED FROM RAILS

	St. Louis	Dallas		St. Louis	Dallas
½ in and larger	$2.35	$2.48	⅝	$2.75	$2.88
¾	2.45	2.58	⅞	3.35	3.48
⅞	2.55	2.68	1	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Jan. 6	Common: One Month Ago	Common: One Year Ago	Paving Block: 3-inch*	Paving Block: 3½-inch*
New York (del.)	$20.40–22.40	$20.40–22.40	$18.50	$45.00†	$51.00†
New York (at dock)	17.00	17.00	15.25	.....	.....
Chicago	12.00	12.00	12.00	42.00	45.00
St. Louis, salmon (del.)	15.00	15.00	16.00	40.00	42.50
Denver, salmon	9@10	9@10	12.00	.....	.....
Dallas	14.10	14.10	11.10	35.00	.....
San Francisco	15.00	15.00	15.50	.....	.....
Los Angeles	11.00	**11.00**	11.50	(not used)	
Boston (del.)	**19.50**	19.00	17.50	45.00	50.00
Minneapolis (del.)	13.75	13.75	13.50	.....	.....
Kansas City	*13.50*	14.00	16.50	(no market)	
Seattle	15.00	15.00	15.00	.....	55.00
Cincinnati	15.50	15.50	17.00	40.00	45.00
Montreal	20.25	20.25	17.50	100.00‡	.....
Detroit (del.)	16.00	16.00	16.00	38.40	41.50
Baltimore	18.00	18.00	18.00	40.00	45.00
Atlanta	12.00	12.00	10.50	40.00	.....
New Orleans	15.00	15.00	15.00	60.00	75.00
Birmingham	14.50	14.50	12.50	40.00	45.00
Philadelphia	18.00	18.00	17@20	40.00	50.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	12@14	12@14	14.00	.....	.....

*For paving blocks 3x8½x4 and 3½x8½x4 respectively. †In cars. ‡Imported.

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Jan. 6 on Trucks*†	New York: One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco†	Perth Amboy N. J., Factory*
4x12x12	$0.1027	$0.1112	$0.076	$0.105	$0.068	$0.108	.....
6x12x12	.1541	.1667	.104	.....	.09	.156	.....
8x12x12	.1926	.2084	.142	.205	.126	.244	.....
10x12x12	.....	.....	.182	.....	.158	.....	$0.252
12x12x12	.....	.....	.202	.....	.188	.....	.312

*5 per cent off for cash.

Partition tile	4x12x12	8x12x12	12x12x12
Boston	*$0.08*	*$0.165*	*$0.27*
Minneapolis (f.o.b. cars)	.068	.1175	.205
Minneapolis (delivered)	.076	.13	.225
Cincinnati	.064	.1295	.1726
Kansas City	.088	.154	.252
Denver	.075	.155	.188
Seattle	.09	.18	.26
Los Angeles	.085	.172	.....
New Orleans	.11	.205	.31
Detroit	.0707	.1326	.1853
Montreal	.10	.....	.....
Baltimore	.124	.268	.....
Atlanta	.0895	.1837	.....
Dallas	.112	.19	.31
Birmingham	.11	.124	.255
Pittsburgh	.068	.128	.179
Cleveland	.062	.12	.....

STRUCTURAL MATERIAL—Following are base prices per 100 lb in carload lots, f.o.b. mill, Pittsburgh and Birmingham, together with quotations in less-than-carload lots from warehouses at places named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$2.00	$2.05	$3.34	$4.15	$3.25	$3.10	$3.30
Channels, 3 to 15 in.	2.00	2.10	3.34	4.15	3.25	3.10	3.30
Angles, 3 to 16 in., ¼ in. thick	2.00	2.10	3.34	4.15	3.25	3.10	3.30
Tees, 3 in. and larger	2.00	2.10	3.34	4.15	3.35	3.10	3.30
Plates, ¼ in. thick and heavier	1.90	2.00	3.34	4.15	3.25	3.10	3.30

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York, Jan. 6	New York, One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in	$2.60	$4.20	$4.50	$3.50	$3.65	$5.00	$4.75
CONE HEAD BOILER							
½ in	2.90	$4.40	$4.70	$3.70	$3.85	$5.20	$5.00
⅝ and ¾	3.05	4.55	4.85	3.80	4.20@4.45	5.35	5.15
⅞ and 1	3.30	4.80	5.10	4.05	4.60	5.60	5.50

NAILS—The following quotations are per 100 lb. keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	$2.65	$2.85	$3.05	*$4.50*	**$4.25**	$2.83	$4.95
Cut	*2.80*	2.90	.....	5.25	5.00	2.93	5.00

SHIP SPIKES—Current prices per 100 lb.:

In	San Francisco: Galv.	San Francisco: Black	Seattle Black
½	$7.50	$5.75	$7.75
⅝	7.05	5.30	5.65
¾	6.90	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.25.

PREPARED ROOFINGS—Slate-surfaced roofing (4 ply) in rolls of 108 sq.ft costs $2.46 per roll to contractors in carload lots f.o.b. New York.

Single shingles, slate finish, cost *$6.36* per square (sufficient to cover 100 sq.ft.) in carload lots, f.o.b. New York. Strip shingles (4 in 1) f.o.b. New York, in carload lots to contractors, *$5.00* per square.

ROOFING MATERIALS—Prices f.o.b. New York, to contractors in carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	*$72.00*
Asphalt coating, per gal	33
Asphalt felt, per 100 lb	3.71

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 83 per cent; "A," 87 per cent; "B," 89 per cent. Double thickness "AA," 82 per cent; "A," 86 per cent; "B," 89 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	*$2.30@2.40*	$3.60	$3.50	$4.00	$3.89
No. 12	*2.35@2.45*	3.65	3.55	4.05	3.94
No. 14	*2.40@2.50*	3.70	3.60	4.10	3.99
No. 16	*2.50@2.60*	3.80	3.70	4.20	4.09
Black					
Nos. 18 to 20	**$2.95@3.05**	4.25	3.75	4.70	4.15
No. 22	**3.10@3.20**	4.40	3.90	4.85	4.30
No. 24	**3.15@3.25**	4.45	3.95	4.90	4.35
No. 26	**3.25@3.35**	4.55	4.05	5.00	4.45
No. 28	**3.40@3.50**	4.70	4.20	5.15	4.60
Galvanized					
No. 10	*$3.15@3.25*	4.55	4.10	5.05	4.40
Nos. 12 to 14	*3.25@3.35*	4.65	4.20	5.15	4.50
No. 16	*3.35@3.45*	4.75	4.30	5.30	4.60
No. 18	*3.50@3.60*	4.90	4.45	5.45	4.75
No. 20	*3.65@3.75*	5.05	4.60	5.60	4.90
No. 22	*3.70@3.80*	5.10	4.65	5.65	4.95
No. 24	*3.85@3.95*	5.25	4.80	5.90	5.10
No. 26	*4.10@4.20*	5.50	5.05	6.00	5.35
No. 28	*4.35@4.45*	5.75	5.30	6.25	5.60

For galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York: Jan. 6	New York: One Year Ago	Chicago: Jan. 6	Chicago: One Year Ago
Raw in barrels (5 bbl. lots)	*$0.81*	$0.93½	$0.84	$1.00

E. N.-R. Prices of Construction Materials

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Jan. 6	1 Yr. Ago	Jan. 6	1 Yr. Ago
Red	$15.25	$15.25	$16.75	$16.75
White	15.25	15.25	15.25	15.25

Lumber

Prices wholesale, per M. ft. b.m., to contractors in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to contractors at yards.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft.
3x3 and 4	$26.00	$27.00	$28.00	$31.00
3x6 and 8	26.00	27.00	28.00	31.00
4x4-6 and 8	26.00	27.00	28.00	31.00
3x10 and 12	26.00	27.00	28.00	31.00
3x14	30.00	30.00	32.00	34.00
4x10 and 12	26.00	27.00	28.00	31.00
4x14	30.00	30.00	32.00	34.00
	24 Ft. and Under		25 to 32 Ft.	33 to 40 Ft.
6x10	$28.00		$30.00	$32.00
6x14	34.00		36.00	38.00
8x10	28.00		30.00	32.00
8x14	34.00		36.00	38.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York		Chicago	
	20 Ft. and Under L.L.Y.P.	22-24 Ft. L.L.Y.P.	20 Ft. and Under No. 1 L.L.Y.P.	Up to 32 Ft. No. 1 Douglas Fir
3x4 to 8x8	$43.00@**$44.00**	$44.00@**$45.00**	*$40.00*	*$40.00*
3x10 to 10x10	50.00@ **51.00**	51.00@ **52.00**	47.00	*40.00*
3x12 to 12x12	57.00@ **58.00**	58.00@ **59.00**	*56.00*	40.00
3x14 to 14x14	65.00@ **66.00**	66.00@ **67.00**	....	*40.00*
3x16 to 16x16	77.00@ **78.00**	78.00@ **79.00**	....	*41.50*

New York—Wholesale price of long-leaf yellow pine timbers (rough) to dealers; to contractors, delivered from lighters or cars to job, $5@$10 additional. Short-leaf pine costs $3 per M. ft. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 32 ft. and $1 for each additional foot from 32 to 36 ft.

Other Cities

	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	R.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	*$48.50*	$48.00†	$50.00	*$51.00*	*$58.50*	$58.00†
Seattle	....	24.00	....	....	....	25.00
New Orleans	36.00	....	....	....	52.00	.....
Baltimore	32.50	49.25	53.00	60.00	38.00	49.75
Cincinnati	37.00	73.00	73.00	85.00	48.00	77.00
Montreal	50.00	55.00	....	....	60.00	65.00
Los Angeles	.....	33.00	....	.....	.....	33.00
Denver	.....	32.75	32.75	32.75	.....	**34.75**
Minneapolis	42.50	**39.25**	34.50	.....	45.00	**39.25**
Atlanta	31.00	....	....	.....	34.00	.....
Dallas	56.00	....	....	.....	56.00	.....
Kansas City, Mo.	42.50	40.75	....	.....	*57.50*	40.75
Birmingham	32.00	....	....	.....	34.00	.....
Philadelphia	54.00	38.00	38.00	45.00	65.00	38.00
Detroit	47.75	46.75	....	.....	61.75	46.75
St. Louis	41.00	....	....	.....	53.00	.....

	1-In. Rough, 10 In. and Under x 16 Ft.			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	*$44.00*	$42.00†	$45.00	*$49.00*	$48.00†
Seattle	....	22.00	....	....	23.50
New Orleans	38.00	46.00	....	28.00	34.00
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	70.00	79.00	75.00	38.00	85.00
Montreal	45.00	50.00	40.00	65.00	50.00
Los Angeles	.....	27.00	....	....	36.00
Denver	.....	32.75	33.25	.....	30.25
Minneapolis	**42.50**	*35.75*	34.75	36.00	*33.75*
Atlanta	22.00	....	....	28.00	.....
Dallas	52.25	....	....	56.00	.....
Kansas City, Mo.	*50.25*	*40.75*	.....	*40.00*	*35.75*
Birmingham	**27.00**	....	....	45.00	....
Philadelphia	30.00	38.00	36.00	35.00	37.00
Detroit	39.75	37.00	....	46.50	41.25
St. Louis	43.00	....	....	29.00	....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M. ft. to contractors.

Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.

Denver—Quotes dealers price to contractors on large projects.

St. Louis—Wholesale price to contractors, f.o.b. cars, $3 per M.ft. additional.

Seattle—Price to contractors, delivered.

Dallas—Wholesale to contractors, $10 per M.ft. additional.

*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Jan. 6	One Month Ago	One Year Ago
$2.25@$2.30	$2.25@$2.30	$2.30

CONCRETE BLOCKS—Standard 8x8x16-in., delivered to job, each:

Denver	$0.22	St. Louis	$0.18*
Detroit	.16	Boston	.21
New Orleans	.25*	Minneapolis	.14*
New York (Brooklyn)	18@.20	Philadelphia	18@.20
Pittsburgh	.16	*F.o.b.	

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington: Discount 5 points less than discount for Eastern territory.

Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.

Arizona: Discount 10 points less than discount for Eastern territory.

Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.

North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¾-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1-in., 2 ft. 4 in. Following is price per pound for ¾-in. and larger, in 1200-ft. coils:

Boston	$0.22	New Orleans	$0.21
New York	.24½	Los Angeles	.25
Chicago	.23½	Seattle	.22
Minneapolis	.24½	St. Louis	.22½
San Francisco	.22	Montreal	.17
Atlanta	.30	Detroit	.24½
Denver	.24@.25	Baltimore	.18
Cincinnati	.21	Kansas City	.29
Dallas	.31	Birmingham	.26@.27
Philadelphia	.25		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.265*	$0.2875*
Boston	.245	.265
Kansas City	*.2025*	*.2225*
Seattle	.165	.19
Chicago	.195†	.2175†
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.225	.306
Los Angeles	.1875	.2225
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.1675	.1895
Birmingham	.22	.24
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

*Special gelatin in case lots. †Quantities above 500. lb. and less than a ton.

CHEMICALS—Water and sewage treatment chemicals, spot shipments in carload lots, f.o.b. works:

Sulphate of aluminum, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	4.80@4.90
Soda ash, 58%, in bags, per 100 lb.	*1.32½@1.37½*
Chlorine, liquid, tanks, per lb.	.04@.04½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	2.00@2.10

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.735
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.29	St. Louis	.43
Cleveland	.19	St. Paul	.60
Denver	1.15*		

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.